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THE PLANS FOR THE BROADWAY TUNNEL, for rapid transit, are outlined in the New York *Times*. The plan worked out by Mr. W. B. PARSONS, one of the engineers of the Commission, as there given, includes two double-decked tunnels, next to the curb lines, and made of masonry walls, with steel girder floors and roof. Between the two tunnels and under the surface cable track would be a subway for pipes, sewers, etc. This plan makes the street surface permanent, and provides for access to the subway at stations and other points. Another plan, prepared by Chief Engineer WILLIAM E. WORTHEN, of the Commission, goes somewhat deeper than the old Arcade tunnel, and takes up the entire roadway, with the four tracks on a level, with the same general system of walls and girders as the other. The latter plan leaves the street surface and the pipes, sewers, etc., to be provided for separately, practically as at present. Messrs. OCTAVE CHANUTE, JOSEPH M. WILSON, THEODORE COOPER and JOHN BOGART are named by the *Times* as the experts now discussing the merits of these two plans. It is an excellent committee of prominent engineers, and some good plan should result from their study of the situation.

THE CONTRACT FOR THE HIGH-POWER GUNS is given to the Bethlehem Iron Co. for $3,580,373. The prices are as follows: 25 8-in. breech-loading, built up, forged steel rifled guns, $17,246.55 each; 50 10-in., same pattern, $35,747.58 each; 25 12-in., same pattern, $54,473.22 each. Delivery of the 8-in. guns is to commence in 2 years, but the total order will only be filled in 12 years. It is conceded that the same guns could have been made, even within less time, at the government gun factory at Watervliet, at a saving of about $1,000,000. But the government has concluded that it is good policy to encourage the establishment of private works for this purpose; and further, Watervliet could be fitted up to turn out another 100 guns simultaneously with the Bethlehem output. The combined efforts of the two establishments would not meet the present demand for high-power guns for coast defence.

OIL AS FUEL FOR TORPEDO BOATS is being seriously discussed by the U. S. Navy Department. Its use would dispense with one stoker, be cleaner and it would be more easily handled than coal. The question of safety is one yet undecided, and the lack of foreign fuel stations would prevent its employment at present for our larger war vessels.

ANOTHER DRY DOCK is to be built at the Brooklyn Navy Yard. The new dock will be 600 ft. long, long, or 100 ft. longer than the last built. It will be of the Simpson type, with a granite coping instead of wood. The estimated cost is $600,000, or more, according to detail. This yard now has two dry docks, one the old granite dock, and a Simpson timber dock, finished last year.

THE NEW SAULT STE. MARIE CANAL LOCK, says Gen. POE, will be 1,200 ft. long in the walls, 100 ft. wide, with 21 ft. of water on the miter-sills and a single lift of 18 ft. The length between gates available for lockage is 800 ft. In the last two years 242,000 cu. yds. of material have been removed, of which 100,000 cu. yds. were sandstone rock. The aggregate cost of this excavation alone has been about $230,000. The estimated cost of the coffer dam is $195,393. There are nearly five times as many linear feet of culverts in this lock as in that of 1881, and the cost is put at $285,000. The floor and foundations are estimated to cost $170,000. The 70,000 cu. yds. of masonry in the lock walls is estimated at $14 per yard, or $980,000. The gates will probably be metal and they will cost $250,000. The lock machinery, house, etc., is put down at $100,000. The new movable dam will cost $191,000; deepening of the canal, $732,000; new piers, $90,000; engineering and office expenses, $300,000. With contingencies at 25% ($947,773) pumping, etc., added, the total cost of the new lock, its approaches and a deeper canal, is put down at $4,585,865. As an example of the gain to shipping by the new lock, it may be said that the *E. C. Pape* now carries 3,000 tons of ore on 14 ft. draught; on 19 ft. she would carry 4,800 tons, and this would mean a gain to the owners of $1,800 on a single down trip.

THE EFFICIENCY OF A CENTRIFUGAL PUMP at a low lift, compared with the efficiency of a scoop wheel, has been tested on an English drainage work, and resulted in favor of the pump, as reported in *Engineering*. The district drained is about 6,000 acres in extent, and since 1861 has been drained by two condensing beam engines of about 85 I. HP., each driving a scoop wheel 31 ft. in diameter, and lifting the water about 5 ft. Recently one of the scoop wheels was replaced by a Gwynne centrifugal pump. The comparative tests of efficiency showed the following results:

	Centrifugal pump.	Scoop wheel.
Work done per minute, ft.-lbs.	1,673,234	1,195,166
Work done per 100 lbs. coal, ft.-lbs.	30,422,443	19,585,110

This seems a very good record for a centrifugal pump, considering the antiquated type of engine, the very low head, and the fact that the power was transmitted by gearing from the engine to the pump.

THE RAIN-MAKERS, Gen. DYRENFORTH, Prof. MYERS and C. W. CASLER, balloonists, Dr. ROSELL, chemist, and others, are at Midlands, Texas, where they are preparing to make the government experiments which are hoped to result in rain. They have 100 balloons of from 1,500 to 5,000 cu. ft. gas capacity, many kites, miles of wire and quantities of dynamite. We shall soon see what all this is worth.

AN EARTHQUAKE AND TIDAL WAVE at the mouth of the Colorado River, add to the wonders of that locality, and seem to indicate that the earlier convulsion of June 30 had considerable to do with the yet unexplained change of course in the Colorado, and the flooding of the great basin of South California. The accounts of Aug. 9 are vague and as yet unreliable. But there has undoubtedly been some violent commotion in that region. Indians coming from Yuma report mud volcanoes, great crevasses, the burning of a sulphur mountain and a tidal wave "100 ft. high." The country effected lies around the head of the Gulf of California.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision on the Shore Line of the New York, New Haven & Hartford R. R., near Branford, Conn., on Aug. 10. A construction train taking Italian laborers out to their work on the road was stopped for orders at Branford and there sidetracked, but the switch was not closed. The train was run into by a light engine which is said to have been following at a one-minute instead of five-minute headway. Another account states that the train was on the main track, and that the engine was too close to be warned in time by the flagman. The rear car was telescoped and 10 of the laborers were injured. The rest of the laborers attempted to assault the driver and fireman of the light engine, but were beaten off. A misplaced switch caused a rear collision between an express train and a freight train on a sidetrack on the Wabash R. R., at Homer, Ill., Aug. 7. The engine, baggage and mail cars and 5 freight cars were wrecked. One man was killed and 6 were injured. A similar accident occurred on the same date to the Pennsylvania R. R. limited express from Chicago to New York on the Pittsburg, Fort Wayne & Chicago, at East Palestine, O. The engine was overturned, the baggage and smoking car thrown down the bank, one sleeping car overturned, and the end of another crushed in. One man was killed and two were injured. Train wreckers moved a rail out of place on the Grand Rapids & Indiana R. R. near Cooper, Mich., Aug. 5, and a train went over a 30-ft. bank, a Wagner car containing 12 passengers turning over and over in its descent. About 10 persons were seriously injured, and a number of others more or less bruised and cut.

A TRESTLE on the Kanawha & Michigan R. R., 16 miles south of Charleston, W. Va., gave way under a freight train Aug. 10, and 14 cars were smashed.

A LONG COAL TRAIN is noted by the Pottstown, Pa., *Ledger*. This train was taken over the Philadelphia & Reading Ry. and was made up of 90 long "hopper" cars carrying an average of about 25 tons of coal each, or 2,375 tons in all. Each hopper car is 34 ft. 1 in. long, and including engine and caboose car in the rear of the train, the whole train was 3,100 ft. long. The ordinary train is made up of 40 to 45 of these hopper cars. The engine hauling this train weighed over 75 tons, loaded. This long train was an experiment and was entirely successful. It should be noted that the Reading line has a continuous down grade from the coal regions to tidewater, or "with the trade." On the return trip the same engine described above hauled back 240 of the old four-wheel empty coal cars, equivalent to 60 of the empty hopper cars.

THE USE OF DISINCRUSTATORS in locomotive boilers is being tried in India. Experiments have been made on the Chaman Extension, Eastern Bengal, Northwestern and Oudh & Rohilkund railways with a fluid extract of the leaves of the eucalyptus to prevent and remove scale from boilers, with satisfactory results so far in all cases, but the experiments are not complete, and are being continued.

ARTIFICIAL FUEL FOR LOCOMOTIVES is to be used by the Southern Pacific Co., according to the San Francisco *Enquirer*. A plant for the manufacture of artificial fuel brick from coal dust and asphaltum has been purchased in England and is now being set up in San Francisco. It will cost $75,000 and have a capacity of 5 tons of bricks per hour. At present coal is a very large item of expense to the Southern Pacific Co., it being nearly all brought from Victoria by steamer. The use of this fuel is stated to have been quite successful in England, and the experiment of the Southern Pacific Co. will be watched with interest.

AN ENORMOUS MICROSCOPE is said by one of our exchanges to be under construction by the Poeller Physical Optical Institute of Munich, for exhibition at Chicago in 1893. It will magnify to "16,000 diameters," or as ordinarily fitted, to 11,000 diameters. An electric light of 11,000 c. p. is to be used for illuminating the image, which is to be projected on a screen. As the heat from this powerful light would derange the focus by expansion of the metal, an ingenious device is used to cool the metal. This is a small copper cylinder filled with liquid carbonic acid under a pressure of 350 lbs. to the square inch. It is connected with the microscope in such manner that an electric regulator automatically opens a valve and allows a drop of the acid to escape in a spray on the metal to be cooled; the liquid immediately evaporates and produces intense cold. The whole cost of the instrument is said to be $9,000.

Propelling Machinery of Protected Cruiser No. 12, U. S. Navy.

(WITH INSET.)

Probably not one of the vessels of our new American navy is of more interest to engineers generally than the vessel whose propelling machinery, designed to develop 21,000 I. HP., we illustrate in this issue.

Secretary TRACY is quoted as considering her "without a parallel among the war ships of the world. She unites a sufficient armament with complete protection against light guns, while at the same time the vessel will have a sea speed and a coal endurance hitherto unknown in ships of war. No merchant vessel that she meets, armed or unarmed, can escape from her."

In a recent article in the *North American Review* he further said:

The armaments of *The Pirate* and her sister ship, Nos. 12 and 13, comprising one 8 in., two 6 in., and eight 4-in. guns, with 20 rapid fire-guns, are a match for any armament that the converted commerce-destroyers of the day can carry. Armor protection they have also of a limited character, but their two essential features are coal capacity and speed. The former gives them a radius of action of 25,000 miles, while the latter, developed by engines of over 20,000 HP., propelling three screws, is placed at a maximum of 22 knots and a sustained average of 21 knots. They can steam around the world without touching at any point for coal, and they can overtake with ease the fastest transatlantic liner of the present day.

It was long ago said that he who fights and runs away may live to fight another day. *The Pirate* has the immense advantage of being able to choose her adversaries. She has guns enough to enable her to give a good account of herself against any vessel except those heavily armed and armored, but her policy would be rather to avoid a fight with any vessel where the result was doubtful. For with her combined speed and coal endurance she could inflict enormous damage upon an enemy's merchant vessels as well as upon the lighter vessels of his navy; and barring accidents to her machinery or the mischance of being shut up in port, the enemy would be powerless to defend himself against her, since no ship with guns and armor heavy enough to whip her could overtake her.

Of course the chief interest in this vessel centers in the motive power by which she attains her enormous speed. The feature of great novelty in this is the employment of three screws to drive the vessel, turned by three independent triple-expansion engines, each of which is in a separate water-tight compartment, so that the injury of either will not affect the others.

The machinery of this vessel is described as follows in the report of the Bureau of Steam Engineering just issued:

7,350-TON PROTECTED CRUISER.

This ship is intended to maintain a sea speed of 21 knots, and to attain this it has been found necessary to provide her with motive machinery capable of developing from 20,000 to 21,000 I. HP.

Knowing that it was extremely improbable that shafting of the great size necessary to transmit this enormous power to twin-screws could be obtained in this country, either in reasonable time or with any guaranty as to its strength, the Bureau decided to depart from the usual practice and to divide the power into three parts instead of two, each being developed by a separate engine driving its own screw. It was still further influenced to do this by the knowledge that even in case of the recurrence of so remarkable an accident as that which lately happened to the *City of Paris*, this cruiser would still have a reserve of power sufficient to drive her at a good rate of speed. Indeed it is almost impossible to conceive a combination of circumstances or accidents that would render her entirely helpless.

A feature of the design that carries a strong argument in its favor is that by means of clutch-couplings either propeller can be disconnected from its engine and left free to revolve, thus retarding the way of the ship but very slightly when she is being propelled by one or two engines. A still further advantage is that in moderate cruising, say with one-third power, a few boilers can be used with the high steam pressure for which they are intended and one engine driven at the full power for which designed; by this means the power will be obtained economically instead of wastefully as in the case when a large engine is run at a low power. It is estimated that with one-third power and one screw the ship can be driven about 15 knots; with two screws and two-thirds power, from 18 to 19, the screws not in use being allowed to revolve freely in either case.

There is but little information at hand in regard to propulsion by three screws. A number of torpedo cruisers having them are built or building for the Italian navy and a cruiser of 6,000 tons so fitted is now being built in France. A number of experiments were also made with them in the latter country on the launch *Carpe*. It is not supposed by the bureau that three screws will prove a more efficient mode of propulsion than two; on the contrary, it believes that except for the highest power they will prove slightly less efficient, but its reasons for adopting them have already been given.

The engines are to have cylinders of 42, 59 and 92 ins., diameter, with a common stroke of 42 in. and are precisely like those designed for cruiser No. 6, except the air pumps, as described before, three engines being employed instead of two. They are arranged in three separate water-tight compartments, each being complete in itself, with all its auxiliaries, and entirely independent of the others, so that one or two might be completely disabled without in the least interfering with the working of the other.

The air pumps are two vertical, single-acting lifting pumps for each engine, the pumps being 22-ins. in diameter by 2'-ins. stroke. They are driven by two simple engines with cylinders 7-ins. in diameter and 12-ins. stroke, arranged to exhaust into the condenser or into either receiver. The engines are geared to make 2½ complete revolutions for each double stroke of the pump to which it is attached.

In the experiments with the *Carpe*, referred to, it was found that when the three propellers were placed abreast of each other the efficiency of the center one was greatly impaired by the interference of the side ones with the water flowing to it. For this reason the side propellers have been placed in this cruiser about 15-ft. forward of the center one, thus avoiding as much as possible working the latter in the race of the former. It will also be noticed that looking at the ship from aft, the propellers are not in the same horizontal line, but that the side ones are placed as high as their diameters will permit; also that to bring these propellers clear of the ship's sides the side shafts incline outwards from the center line of the ship ¾ and also slightly upwards. The shaft of the center propeller is in the central longitudinal plane of the ship and inclined slightly downwards.

The central screw will have four blades and about 10% more pitch than the side ones, as it will work in more or less disturbed water. The side screws will be three-bladed and the blades of all the propellers will be adjustable and will be set to the pitch on trial found to be the most efficient.

Steam will be supplied by eight main and two auxiliary boilers, all built of mild steel. Six of the main boilers are 15 ft. 6 in. in diameter outside and 21 ft. 3 ins. long; and two are 11 ft. 8 ins in diameter and 18 ft. 8½ in. long. The shells of the large boilers are 1¼ in. thick; those of the small ones 1⅛ in. The auxiliary boilers are the same as those for the armored cruiser No. 2, and all the boilers are intended for a working pressure of 160 lbs. per sq. in. All the main boilers are of the Scotch type, double-ended, and with 2¼ in. steel tubes. Each large boiler has eight corrugated steel furnaces of 3 ft. 3 ins., inside diameter, and each small one four, with an internal diameter of 3 ft. 6 ins. The heating surface of each large boiler is 5,932 sq. ft., of each small one 2,870 sq. ft., and of each auxiliary 968¼ sq. ft., making a total of 43,269 sq. ft. The total grate surface is 1,285 sq. ft., each large boiler having 175.5 sq. ft., each small one 84 sq. ft., and each auxiliary 32 sq. ft. The auxiliary boilers are placed above the protective deck.

The main boilers are arranged in groups of two, in four separate water-tight compartments, with five athwartship fire-rooms and three smoke-pipes.

Forced draft will be on the closed fire-room system, each fire-room being supplied with centrifugal fan blowers.

Feed-water will be supplied by a main and auxiliary feed pump in each working fire-room and an auxiliary feed pump in each engine-room.

There will be evaporators to make up the loss of fresh-water to the boilers and to supply the distillers, reversing and turning engines, fire and bilge pumps, ice machine, steam ash hoists, capstan engine, and all the other auxiliaries now fitted in the most modern ships.

On our inset sheet are shown the general arrangement of the machinery and drawings of the main boilers and the engines. There are six of the large size boilers illustrated and two smaller ones of the same general pattern. In the boiler illustrated there are 1,128 tubes, each 2¼ ins. diameter. Of these 312 are stay-tubes of No. 6 Birm. wire-gage thickness, and 816 are ordinary tubes of No. 12 B. W. G.

At the meeting of the British Institution of Naval Architects last March, a paper was read by Mr. J. H. BILES, entitled "Some Recent Warship Designs for the American Navy." We extract the following from his description of Cruiser No. 12:

This vessel has a protective deck 2¼ ins. thick on the flat and 4 ins. on the slope, extending to 4½ ft. below the water-line at the side, and to a foot above at the center. The battery is comparatively a light one, being four 6-in. guns and eight 4-in. rapid-firing, and about eighteen machine guns and six torpedo tubes.

A cellular structure 5 ft. wide will be worked next the ship's side the whole length of the vessel. In the way of the bunkers this will be filled with patent fuel, thus forming a thick protection against machine-gun fire. Forward and aft of the bunkers this structure will be filled with some water-excluding material. In the way of the 4-in. guns there will be 4-in. steel protection, and in the way of the machine-guns there will be 2 in. steel.

It is estimated that the radius of action at 10 knots with bunkers full will be 26,000 knots.

This vessel is well divided, and would give a good account of herself against most cruisers; but she is designed to run away from cruisers, and not to fight them, her function being to catch and destroy all the merchant steamers of an enemy that she possibly can. She would not hesitate to fight and try to destroy any of our merchant vessels fitted as armed cruisers.

This vessel is about the same length as the 17 and 18 knots merchant mail steamers, and no doubt could very easily overhaul any vessel of her own length in almost any weather; but, even though she may have a sustained sea speed in moderate weather of 21 knots, it is very doubtful whether, in average Atlantic weather, she could catch such vessels as the *Teutonic* and *City of Paris*, for their extra length of considerably over 100 ft., and their extra weight, which would be nearly double, would inevitably tell in a seaway. It is further doubtful whether the bow of this vessel above water is, either in shape or height, well adapted for driving against a head sea at such a high speed. Her freeboard forward is 19½ ft., which is low compared with the *City of Paris*, which has 32 ft. This could readily be increased without seriously interfering with her efficiency in other ways. It is not very apparent what is gained by having a long projecting under-water stem in such a vessel. To use it would be to cripple herself in the quality which everything has been sacrificed for, namely, speed. A straight stem, such as most merchant ships have, but with considerable flare out, would probably improve her speed in a head sea, and would certainly keep her drier forward.

The reason alleged for adopting three screws is that the vessel can be driven at less power with the center screw alone at the lower speeds than with two screws, or than with one screw in a twin-screw ship, where propulsion would have to be balanced by the rudder. This is undoubtedly true for low speeds, but a preferable arrangement could be made by having two engines on the middle screw instead of one.

It may be interesting to record here an actual fact in connection with running a twin-screw ship with one screw only. The *City of New York* ran about half-way across the Atlantic with two screws, averaging 18.5 knots for 80 revolutions of both screws. An accident then happened which disabled one engine, and necessitated disconnecting the screw and shaft from the engine. She then ran the remainder of the voyage with one engine only, the other screw running loose. At 80 revolutions she maintained a speed of 16.3 knots, with 3° of helm. The power necessary to drive the ship when running at 16.3 knots with two screws in ordinary work, compared with the crippled condition stated above, is actually more.

The question of sustained sea speed is probably best determined by estimating the power which would be obtained in ordinary merchant steamer practice in ordinary sea-going work from the heating surface of the boiler. On the assumption that each I. HP. requires 3 sq. ft. of heating surface, which is average merchant ship practice, we get 14,421 I. HP. for Cruiser No. 12. The speed in ordinary smooth water with this power would be about 20½ knots. [The author here gives a table of speeds of the latest American and English vessels designed, and concludes that the former will be the fastest.]

In the case of cruiser No. 12, the fastest American ship, this result will have been obtained by giving her a length greater than any warship built or building, by giving her a light armament, thus reducing the crew and all their accompaniments, and by simplifying the structure and arrangements generally. Speed and coal endurance are the features of this vessel which have been specially intensified, and Mr. Secretary TRACY'S conception of what is required to destroy commerce seems to have been well worked out by the constructive staff. Whether it is desirable to have a vessel which is capable of doing this work, but which is only a navy ship, rather than to have vessels like our armed cruisers, which can be made remunerative in time of peace, is a doubtful question.

For continuous steaming at high speeds the well-tried mail steamer would be more efficient, as so many opportunities of finding out and making good defects would have arisen. It would be quite easy to arrange in the design of mail steamers intended to act as "commerce destroyers" that structural framing, shaped and situated similarly to a protective deck, should be fitted, on which in time of war thick plates could be laid and secured in no more time than would be taken to get guns and stores on board. Such a deck would admit of better coal protection, especially in the condition when coal is one-half or three-fourths expended, for the remaining coal in an ordinary ship would be many feet under water, whereas in this type it might be nearly all at the water-line. In the way of the cylinders, a belt of vertical armor would have to be fitted round the inside of the engine hatch to

rotect tops of cylinders. Under-water steering would have to be the ordinary every-day method of steering, and not a war-time arrangement only. This latter can be carried out, and has been in the *City of Paris*. Such a mail steamer, constructed with the intention of coping with such a commerce destroyer as No. 12, would be earning money in time of peace, and would be a really efficient protection in time of war.

The objection to such steamers is their size, which affords a larger target, and makes them unhandy in turning. The former objection is met by the fact that though they are more easy to hit they will stand more shots, and their size enables them to carry a larger number of guns in proportion to their greater size, so that the chance of hitting an opponent increases with their own size. As to unhandiness, it is not difficult to make a vessel 500 ft. long turn as rapidly as No. 12 will. It is only a question of increased rudder area, and, if the system of making the rudder a continuation of the lines of the ship be adopted, a very large rudder area can be obtained. In No. 12 the rudder area is 220. In the *City of Paris* it is 250, and could readily be made larger. The latter ship turns a complete circle in less than six minutes.

The building of such a ship as No. 12, which we have nothing to cope with, certainly is an indication of what America is capable of both in conception and construction, and I have thought it of sufficient interest to lay before this Institute for consideration and discussion. Whether vessels specially designed to meet this one or whether an improved type of mail steamers is the right protection, is a question worth some consideration. The most suitable for fighting of our armed cruisers would be very weak in the presence of such a foe; but with protection as indicated above and equal speeds there should be little fear of a contest.

In the discussion on Mr. BILES' paper Admiral Sir JOHN HAY said that in past days when Englishmen thought nothing could touch their supremacy on the seas there was a rude awakening through the Americans building faster and stronger vessels than the English possessed; and they beat the frigates, which were the special pride of the English Navy, in detail. Care should be taken not to allow this to be repeated. Mr. W. H. WHITE, Chief Naval Constructor, said he believed the new United States Navy owed its existence to a financial surplus which no one knew how to dispose of—a happy state of affairs for a navy, but unfortunately without a parallel in England. He criticised the designs for No. 12 on the ground that the maximum speed was calculated with the coal bunkers only one-third full and possibly without all the necessary ammunition and stores on board. He believed that the Americans were counting on realizing in regular cruising a greater proportion of the speed developed on trial than was possible.

Mr. WHITE'S criticisms were taken up and repeated at some length by the *London Times*, and a reply was made by Secretary TRACY in a recent number of the *North American Review*.

In this he showed that American estimates of speed and coal endurance were even more conservative than British estimates. The ratio of total heating surface to calculated indicated horse power is 2.061 in cruiser No. 12, and it exceeds 2 in every one of the new American vessels except the *Newark* and the *Baltimore*. In a dozen English ships, however, representing best practice abroad, this ratio varies from 1.394 to 1.856. The *Blake*, which Mr. WHITE claimed could equal Cruiser No. 12 in speed, has a total heating surface of only 34,060 sq. ft., against 43,269 in the American ship, which has also 37 ft. more length and 7 ft. less beam.

The contract for No. 12 requires that she steam in the open sea for four hours at the rate of at least 21 knots, with an air pressure in the fireroom of not more than 1 in. The contract for building the vessel was awarded to Wm. Cramp & Sons, of Philadelphia, last October, at their bid of $2,725,000. The vessel is to be completed and ready for trial in two and one-half years from date of the contract.

The same firm have recently been awarded the contract for Cruiser No. 13, the sister ship to No. 12, and a duplicate of her in every respect except the battery, which is to be somewhat heavier, comprising one 8-in., two 6-in. and twelve 4-in. breech-loading rifles; sixteen 6-lb. and eight 1-lb. rapid-fire guns; four Gatling guns and four torpedo tubes. The contract price is $2,690,000 and the vessel is to be completed within two years. For every quarter knot increase in speed above 21 knots per hour on her trial, the contractors are entitled to a premium of $50,000, and for every quarter knot decrease a penalty of $25,000 will be assessed.

A New Form of Water Tower.

The cut given herewith illustrates a new form of water tower devised by Messrs. Johnson & Flad, Consulting Engineers, of St. Louis, Mo. As it is well known that the water in the upper half of a stand-pipe is the only portion serving a useful purpose, an elevated steel tank is the ideal structure for this purpose and is very often used.

The trouble has heretofore been to provide a suitable support for the bottom of the tank which will not be too expensive to preclude its use. A flat

A New Form of Steel Water Tower.

bottom must be supported over its entire area, and this is expensive work either with steel columns or stone or brick masonry. In this design the bottom is hemispherical and self-supporting, and can be readily built of flange steel. This bottom is attached to the sides of the tank, and the latter act as plate girders to concentrate the load on the eight steel columns. All of these connections can be closely computed and the design and construction of details offer no great difficulties.

The engineers named are prepared to construct these tanks of all sizes, from 50,000 to 200,000 galls. capacity, and at any elevation from 50 ft. to 150 ft. above the ground. No price is given, but it is said that if a ladder and plain balcony are substituted for the ornamental work shown, the cost will fall considerably below that of a stand-pipe of equal effective capacity.

The connection at the base is made by means of an expansion joint, and in cold latitudes the supply pipe would be double, thus inclosing an air space. It is certainly more comely than a stand-pipe, performs its duty better in not allowing the pressure to fall, will better resist wind pressure, and is generally a neater piece of engineering.

The Comparative Merits of Different Systems of Car Lighting.

VII.

[In resuming the publication of this series of articles, the last of which was published in our issue of May 23, we must, in justice to ourselves, state that the interruption in the publication has not been the fault of this journal. The tests described below on the Frost dry carbureter system were completed last April, and their description has been in type for many weeks. The Railroad Lighting & Manufacturing Co., the owners of the Frost dry carbureter system, requested us, in a letter dated May 5, to delay the publication of the tests until they could be supplemented with tests made on carbureters attached to a car in service. The arrangements for these service tests were soon thwarted, however, by the manufacturers, who insisted that their own engineer should take an active part in the conduct of the tests, a feature of which we could not approve, and which was not approved by one of the experts who was asked to conduct the tests. The Railroad Lighting & Manufacturing Co. has also refused to loan us apparatus for use in further tests proposed to be carried out at Stevens Institute Laboratory; and has withdrawn an invitation it had extended to have further experiments made at its own factory by Professor DENTON of Stevens Institute on behalf of this journal, as soon as the invitation was accepted.

As our attempts to secure further experimental data concerning the carbureter system are thus thwarted, we feel under no obligation to put off any longer the publication of the tests already made.

We take this opportunity to acknowledge the courtesy of the carbureter manufacturers in furnishing us information and affording us every facility for tests and experiments upon their system up to the time when arrangements were in progress for a service test, as narrated above. We greatly regret that they have seen fit to change this policy; and in order that we may do them no injustice we submitted a proof both of the above statement and of the following article to them before publication, offering to publish their criticisms or objections to anything therein contained. Their reply is given at the close of this article.]

THE FUNCTIONAL ACTION OF THE FROST DRY CARBURETER PLANT.

To make clear to our readers the significance of the following experiments on the Frost dry carbureter system of lighting we will summarize briefly the essential features of the system, our previous articles having given a full description of the details.

In the Frost system of lighting, a quantity of gasoline is held in absorption by a mass of cotton wicking in the interior of a flat circular copper case called the carbureter. One of these is placed over each lamp on the roof of the car, as shown in Fig. 47. Quoting from the manufacturers' catalogue:

> In this system the light is produced by burning in the lamps a gas generated in the carbureters. The gas is simply air carrying a certain amount of gasoline vapor. The air is taken from the air-brake service. The gasoline absorbed in wicking is obtained in the carbureters, and the object of the appliances is to bring these substances together, vaporize the gasoline and thus produce the gas.
>
> The carbureter is a round flat box with a hole in the center and having within it a spiral chamber about 40 ft. long, which spiral chamber is filled with cotton wicking. The air inlet to the carbureter is near the center hole; the outlet is near the edge. The air which is to pass into the carbureter is taken through a small copper pipe, which is bent in the form of a conical spiral and placed in the flue of the carbureter directly above the lamp. The object of this spiral coil is to heat the air before it enters the carbureter by the combustion from the lamp, and in this way to furnish the heat that is necessary to vaporize the gasoline and generate the gas.
>
> As a further means of furnishing heat to the carbureter it is surrounded with an air space, which communicates with the inside of the car, so that warm air from the car constantly passes around the outside of the carbureter and out through the ventilator.
>
> When the carbureters are freshly charged, or when the air is very warm, there is a possibility of carrying too rich a gas down to the lamps; to obviate this difficulty a permanent cross connection is made between the air inlet to and the outlet from the carbureter. In this cross connection is a diaphragm with a very small hole, so that a small amount of air is taken across to the gas as it comes

out of the carbureter, diluting it a little, and thus preventing any possibility of too rich or smoky a gas reaching the lamp.

The apparatus described is that first developed by the company, shown in Fig. 43. Since the above was published the manufacturers have substituted the lamp shown in Fig. 44, have done away with the copper coil for heating the air supply, and have obstructed the flue above the lamp so that a greater proportion of the heat from the lamp circulates around the carbureter. The Pennsylvania R. R. have substituted the lamp shown in Fig. 44 for the old style, but still retain the copper coil, and do not use the "deflector plate" seen just above the words "Smoke Bell" in Fig. 47. Thus, in the Pennsylvania system only the warm air from the roof of the car circulates around the carbureter; while in the system now furnished by carbureter manufacturers a considerable proportion of the hot air from the lamp flame passes around the carbureter, and of course heats it more or less.

It is obvious that this latter system is the one in which the general public is chiefly interested. The points on which it desires information relate to the plant as it now is, not as it was two years or more ago, especially as the plant in its present shape is now in use on all the roads using the system at all on any considerable scale, except the Pennsylvania lines, and is the only one now manufactured or sold except on special order.

TABLE VII.—TEMPERATURES IN DEGREES FAHR. IN AND ABOUT THE CARBURETER DURING A SEVEN-HOUR TEST OF THE FROST CARBURETER LIGHT.

[Record of a test made by the Railroad Lighting & Manufacturing Co. at their factory in Philadelphia, Pa., Feb. 17, 1891. From this table the diagram in Fig. 45 was constructed.]

N. B.—The position of the experimental carbureters, as shown in Fig. 48, and elsewhere described, is to be carefully noted. *It is disputed* whether this test represents sufficiently well the conditions of practice.

Time. P. M.	Air meter reading.	Cu. ft. air per hour.	Thermometer No. (For position see Fig. 47.) 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Tank press., lbs.
2:35.	810	6.	74	74	74	71	70	73	71	72	73	71	70
2:45.	820	..	194	124	144	76	80	190	74	72	74	72	70
2:55.	916	57.8	198	154	192	82	108	212	78	74	74	72	68
3:05.	019	55.8	230	182	212	90	110	220	80	78	78	75	65
3:15.	132	67.8	250	210	218	100	112	220	84	80	80	76	63
3:25.	205	43.8	258	214	220	104	114	220	86	82	82	76	61
3:35.	330	45.0	260	220	210	110	110	210	90	84	86	76	60
3:45.	305	9.0	260	226	224	116	110	210	92	86	90	76	58
4:15.	513	41.6	240	222	210	120	110	210	100	94	96	77	55
4:45.	610	19.4	240	222	210	122	120	210	108	100	102	77	53
5:15.	643	6.6	240	214	190	122	114	212	112	106	110	78	52
5:45.	651	1.6	244	211	200	126	130	210	116	110	110	77	51
6:15.	602	9.8	280	240	210	130	122	200	120	114	114	77	51
6:45.	604	....	275	260	210	132	122	205	120	114	116	76	51
7:15.	604	....	250	260	190	122	120	190	120	118	118	76	51
7:45.	604	....	260	260	190	124	116	190	120	118	118	74	51
8:15.	604	....	290	260	200	126	118	190	120	118	118	72	50
8:45.	....	....	270	260	190	124	118	190	120	118	118	72	50
9:15.	....	....	240	260	180	124	120	190	120	118	118	72	50

Air supply was on full to the end, but consumption of air ceased at 6:15 P. M., when a negative reading of the air meter occurred because of a leak, as explained under Table VIII.

When the lights were turned out the air pipes were found filled with oil, two pints or more having been taken out. One-half pint ran out of the meter at the outlet.

About 6 P. M. the windows below and above the lamps were open, probably causing the condensation found in the pipes. The time of the first oil passing over was not noted. ✱ The delivery from regulator was at .9 lb. pressure. The air supply is for 5 lamps and carbureters, which were burning together. The air supply shown on the diagram (Fig. 45) is for one carbureter only, or 1-5 of that given in the above table.

TABLE VIII.—TEST OF THE TEMPERATURES IN AND ABOUT CARBURETERS, AND OF THE EFFECT OF SHUTTING OFF AIR SUPPLY, THROUGH BY-PASS ONLY, AND ALTOGETHER.

[Test made by W. B. D. PENNIMAN, April 13, 1891, on the experimental plant in the factory of the Railroad Lighting & Manufacturing Co.]

N. B.—Air supply given in this table is for one carbureter; in Table VII. for five carbureters in series.

Time, P. M.	Air meter reading.	Cu. ft. air per hour.	Thermometer No. (For position see Fig. 47). 1.	2.	4.	5.	6.	7.	8.	9.	10.	Tank press., lbs.
1:15	350	22	76	76	68	68	70	70	68	70	82	53
1:30	403	12	164	138	75	136	150	78	70	72	82	47
1:45	435	13.6	174	172	72	142	200	80	74	80	84	44
2:00	489	1.6	172	172	84	146	200	86	76	82	84	41
2:15	473	4.8	182	176	90	150	202	90	80	86	84	37
2:30	485	4.8	186	184	96	150	202	94	84	88	86	34
3:00*	497	0	180	184	102	154	158	100	90	92	86	28
3:15	497	−15.6	176	188	104	154	156	104	94	96	86	24
3:30*	†458	0	184	188	104	154	162	106	98	98	86	....
3:45	458	0	174	188	106	154	156	98	100	100	86	....
4:00	458	0	154	204	110	150	250	110	102	102	86	....

*At 3:00 P. M. the by-pass was closed, compelling all air supply to pass around the coil within the carbureter through the wicking, if at all; and at 3:30 P. M. all air supply was cut off.

Pressure in Carbureters.—2.2 lbs. down to 3:15 P. M., and thereafter 1.4 lbs.

† The minus reading of 458 was due to the back pressure on meter, and the latter reversed its motion, the air or gas escaping at a leak which was afterward stopped.

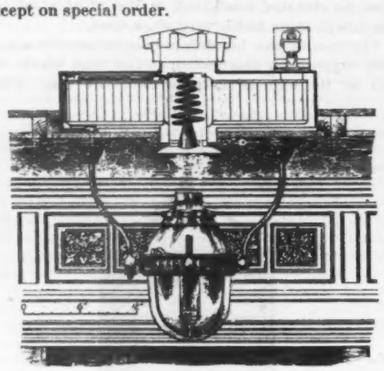


Fig. 43. "Excelsior" Lamp, Frost Carbureter System, as formerly used on the Pennsylvania R. R.

To what temperature is the gasoline in the interior of the carbureter raised in the system of gasoline lighting now furnished by the Railroad Lighting & Manufacturing Co.? The answer to this question is furnished by the accompanying Tables VII and VIII, and the diagrams, Figs. 45 and 46. Table VII and Fig. 45 show the results of a test made by the Railroad Lighting & Manufacturing Co. at their factory in Philadelphia on Feb. 17, 1891, and reported by them to this journal. Table VIII., and Fig. 46 show the results of a test made by Mr. W. B. D. PENNIMAN at the same place on April 13, 1891, the plant being set up by the manufacturers, and the test conducted to their satisfaction. Fig. 47 shows the position of the thermometers used in the tests.

The important facts which the above tests brought to light are, first, that the gasoline in some portions of the interior of the carbureter was *heated to the boiling point;* and, second, that for hours together *no air was used at all*, the gas supplied to the carbureter consisting of pure gasoline steam.

Is the working of the system in service the same, practically, as in the above recorded tests? If so then its working is totally different from that heretofore published and generally accepted. Instead of the carbureter being a chamber through which air passes taking in up its passage a certain percentage of gasoline vapor, it is (at certain times at least) an externally heated boiler in which gasoline is evaporated at a temperature of 119° Fahr. and a pressure of 3 lbs. per. sq. in. above atmospheric.

We greatly regret that no tests corresponding to those above have been made on a carbureter in place on a car; and that the manufacturers, as noted above, have taken what seems to us the mistaken position that they will furnish no facilities for tests of this or any other feature of the carbureter plant by disinterested parties. This being the case, however, we can only lay before our readers the facts concerning the tests above recorded, leaving them to judge for themselves whether the position in which the carbureters were placed during the tests above reported was such as to heat the carbureters above what would frequently occur when they were in place on a car.

Fig. 44. Present Form of Lamp. Frost Carbureter System.

Fig. 48 is a cross-section of the large factory room in which the carbureters were placed. They were supported on two wooden scantlings, 3×4½ ins. in size, running lengthwise of the factory and suspended by rods from the ceiling. The carbureters were placed about 5 ft. apart on these scantlings.

The carbureter manufacturers objected to the publication of these tests, as already stated, giving their reasons as follows, in a letter dated May 5:

The record was not gathered with a view of publishing the same, as the results were obtained in a closed room heated by steam, with the carbureters placed in a position in which they could not, under any circumstances, be placed in a car. It was only a factory or laboratory test made for certain information which we were desirous of obtaining, but not in any sense representing the condition of the system in actual service.

It is certainly true that the carbureter was not in the same position as on a car; but it is by no means certain that the position in which it was placed tended to heat it more than or as much as it would be heated in service. Fig. 47 shows the position of a carbureter on the roof of a car. It will be seen that the outside air and wind have no contact with the carbureter, but touch only the non-conducting exterior mantle, and through that tend to chill only the top and side air passages, which Figs. 45 and 46 show to have in any case a moderate temperature, the heat being greatest under the carbureter where the exterior air has no chance to have a cool-

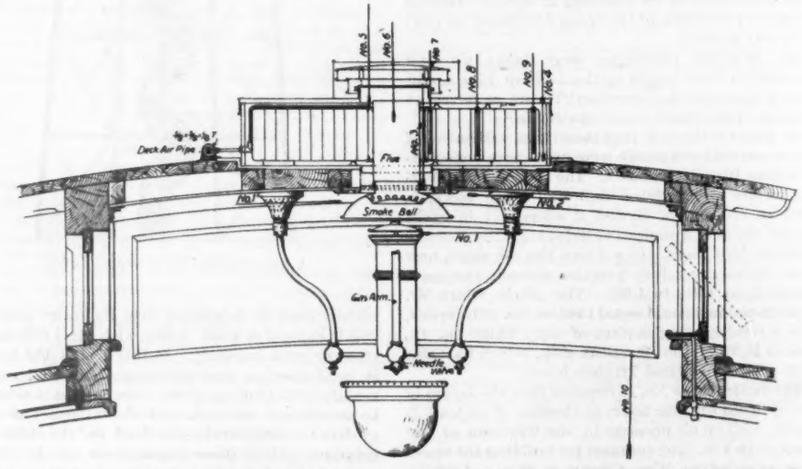


FIG. 47. POSITION OF THERMOMETERS DURING TESTS OF FROST CARBURETER PLANT.

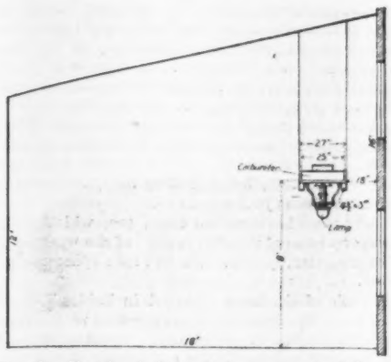


Fig. 48. Sketch of General Arrangement of Experimental Plant in the Factory of the Railroad Lighting & Manufacturing Co., with which the Records of Figs. 45 and 46 were Determined.

ing effect. Again, the interior of the clere story of a car is likely to be hotter than 75°–77° (which was the temperature of the room in which the tests recorded in Table VII were made), rather than cooler, in either winter or summer, in ordinary service.

The scantlings on which the carbureters stood cannot have collected nearly as much heated air beneath the carbureters as would the roof of a car. They were placed midway of the height of a large, open factory (see Fig. 48), on which the heat of combustion would have no sensible effect; and the thermometer record (therm. No. 10) shows that the lamp did not in fact have any sensible effect in increasing the surrounding temperature.

As we have already stated, the temperature of the carbureter will depend largely on the amount of heat from the lamp which circulates around it. Figs. 44 and 47 show the arrangement of air passages in the carbureters and lamps used in the above tests. It will be seen that the direct passage of air up the central flue is cut off by a plate or partition in the smokebell, through which are 14 holes 5/8 in. in diameter. The total area for the passage of hot air up the central flue is therefore 4.30 sq. ins. On some of the lamps in use a "damper" is provided, by which even these 14 holes can be all but closed, leaving only an 0-shaped opening 3/8 in. high at the side of each hole, or only about 0.48 sq. in. in all, or about 1-10 of the full opening. When this damper is closed, therefore, nearly all the gases of combustion are compelled to circulate around the carbureter by entering through the annular opening at the side of the smokebell.

Now, neither in the tests made by Mr. PENNIMAN nor in those made by the manufacturers themselves reported above, were the dampers attached or in use. It seems thus plain enough that on cars having the damper a *larger* proportion of the products of combustion from the lamp may be circulated around the carbureter than was the case in the above reported tests.

In justice to the Pennsylvania R. R. Co. we should state that the description just given does not

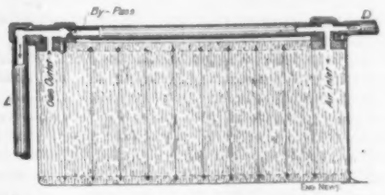


Fig. 49. Passages for Air Through and Around Carburetter.

apply to the lamp and carbureter now in use on their lines. Such of the new-style inverted lamps as are in use on the Pennsylvania lines have no damper; and orders have been issued to remove the perforated plate in the smokebell entirely, leaving a free passage for the hot products of combustion up the central flue, obstructed only by the cone and heating coil shown in Fig. 43.

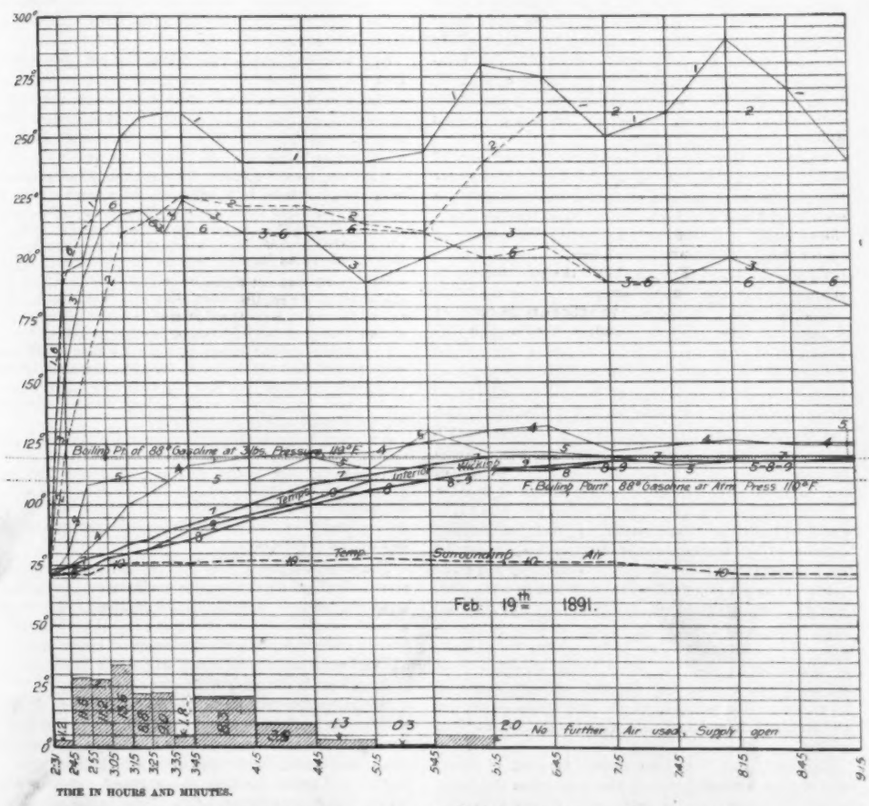

Boiling Pt. of 88° Gasoline at 3 lbs. Pressure, 118° F.
F. Boiling Point 88° Gasoline at Atm. Press. 110° F.
Interior
Wicking
Temp.
Surrounding
Air
Feb. 19th 1891.
No Further Air used, Supply open
TIME IN HOURS AND MINUTES.

Fig. 45. Test made by the Railroad Lighting & Manufacturing Co., Feb. 19, 1891.

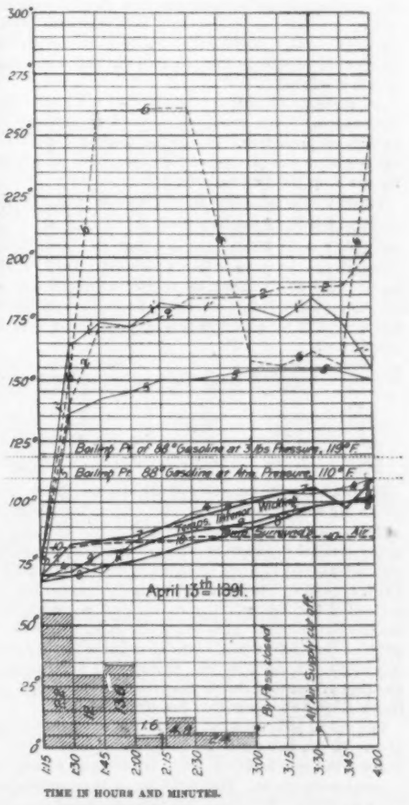

Boiling Pt. of 88° Gasoline at 3 lbs. Pressure, 118° F.
Boiling Pt. 88° Gasoline at Atm. Pressure, 110° F.
Temp. Interior Wicking
Temp. Surrounding Air
April 13th 1891.
By-Pass closed
All Air Supply cut off
TIME IN HOURS AND MINUTES.

Fig. 46. Test made by W. B. D. Penniman, April 13, 1891.

DIAGRAMS ILLUSTRATING THE FUNCTIONAL ACTION AS RESPECTS TEMPERATURES AND AIR CONSUMPTION OF THE FROST DRY CARBURETER PLANT, AS NOW MANUFACTURED BY THE COMPANY [DIFFERING IN SOME RESPECTS FROM THE ORIGINAL P. R. R. PLANT], WHEN TESTED UNDER THE CONDITIONS SHOWN IN FIG. 48.

Fig. 47, with the accompanying notes should be carefully examined, in order that each reader may determine for himself to what extent the differences in the conditions of the tests from those of actual service modified the results.

The notes from which these diagrams are constructed are given in Tables VII., VIII., which should be examined. **The hatched areas** show the **rate** of air consumption in cubic feet per hour **for one carbureter.**

POSITION OF THERMOMETERS.

The position of the thermometers is shown graphically in Fig. 47, and was as follows, the numbers corresponding to those on the several lines of temperature above:

No. of thermometer and line.	POSITION OF THERMOMETER.
1.	(Fig. 45 only) At opening at top of lamp chimney.
1'.	(Fig. 46 only) At side of top of chimney near entrance to air passage.
2.	At metal face to head lining, point of greatest heat upon same.
3.	At throat of mantle, above smokebell; beginning of air passages around carbureter.
4.	Vertical passage around carbureter.
5.	Exit of passages around carbureter.
6.	Exit of heated air through smoke flue.
7, 8 9.	Interior of the wicking and spiral passages of carbureter. The thermometers were immersed in oil contained in tubes with closed bottoms, wicking surrounding the tubes on bottom and sides. Thermometers held in position by corks inserted in the hole through mantle.
10.	Suspended in room to give temperature of the same.

Thermometers 3, 4, 5 and 6 were suspended by corks and surrounded by metal.

In Fig. 45, 46, the records of thermometers 7, 8, 9 are shown by *heavy* black lines; of thermometers 1, 1', 3, 4, 5, giving temperatures of air passages around carbureter, by *light* black lines; and of thermometers 2, 6 and 10 by *dotted* lines.

But the facts brought out in the above experiments are not the only ones which have developed tending to show that the method of operation of this system of lighting may at times be entirely different from what has been generally supposed.

At our request the manufacturers some months ago made experiments on the standard by-pass. To make clear the significance of the results obtained a brief explanation of the by-pass is necessary.

The accompanying sketch (Fig. 49) shows a half-section of the carbureter through the air passages. According to the heretofore announced and accepted theory of the plant, air enters at the "air inlet," passes along the spiral passageway 42½ ft. in length, and finally escapes at the "gas outlet" charged with a considerable percentage of gasoline vapor. But as it issues from the gas outlet it sometimes has too large a percentage of gasoline vapor, so a pipe is led from the "air inlet" to the "gas outlet," and a very small hole or "by-pass" is bored through a diaphragm in the end of this pipe. The capacity of this is claimed to be such that only about 10% of the total air supply passes through it.

This is the theory; let us examine it a little. The air enters the pipe *P* from the deck air pipe at 3 lbs. pressure.

By many different experiments the volume of mixed air and gasoline vapor consumed by the lamp has been determined to be 6 to 8 cu. ft. per hour. In order to reach the pipe *L* leading to the lamp, the air supply may either pass through the by-pass orifice or through the carbureter. It is claimed to pass through both. Evidently the volume which will pass through either will depend on the resistance which it offers.

At our request the manufacturers made tests on the capacity of the standard by-pass to transmit air at various pressures. It was found that 78 cu. ft. of air per hour was passed at 3 lbs. pressure and 47 cu. ft. per hour under 1 lb. pressure.

These two quantities are in almost exactly the ratio which theory calls for, of $\sqrt{1}$ to $\sqrt{3}$, or of 1.00 to 1.732; and if we assume that the discharges through the by-pass will continue to vary as the square root of the head, as theory requires and as we may justly infer, we shall have the following discharges of air through the by-pass under various pressures:

Pressure in— Ounces or pounds.	Inches of water.	Ratio of air discharged.	Discharge in cubic feet air per hour— Observed.	Computed.
½ oz.	0.43	0.1250	..	5.87
1 oz.	1.74	0.2500	....	11.75
4 oz. = ¼ lb.	6.95	0.5000	....	23.50
1 lb.	27.8	1.0000	47.0	47.00
2 lbs.	55.6	1.4142	....	66.47
3 lbs.	83.3	1.7321	78.0	81.40

So much for the capacity of the by-pass. Now, how much air will pass through the charged carbureter at these pressures? On this point, unfortunately, experimental data are wanting. As stated above, we endeavored to have tests made on this point by Prof. DENTON, but our efforts were thwarted by the refusal of the manufacturers to loan a carbureter for use in the test. This being the case, we can only present the facts which show that there is very considerable resistance to the passage of air through the carbureter and leave our readers to judge for themselves how great this resistance is.

The spiral passageway through the carbureter is about 60 ft. in length in the new square form of carbureter, and is filled with wicking as solidly as it can be drawn in. The wicking is then saturated with gasoline. The total interior volume of the carbureter is 2,413 cu. ins. The maximum charge of gasoline is about 5 galls., or 1,155 cu. ins. About 19 lbs. of cotton wicking is used in each carbureter, and this is drawn in flat strips across the spiral passageway at intervals of ⅛ in. for the whole length of 60 ft. It seems certain that this must cause great resistance to the passage of air through the carbureter.

The makers of the carbureters have stated that a person with strong lungs can occasionally blow through a dry carbureter. Whether this could be done when the carbureter was charged we do not know. A strong man can exert about 3 lbs. pressure with his lungs.

But referring to the above table it will be seen that all the air which the lamp uses, from 1½ to 5 cu. ft. per hour, will pass through the by-pass alone with a pressure of much less than ¼ oz., or less than a third of an inch water pressure. Thus, if only 10% of the air supply is to pass through the by-pass, as the manufacturers claim, the resistance to the passage of air through the carbureter must be exceedingly small. The evidence tending to show that this resistance is not small we have already given.

But if the air does not pass through the carbureter or passes through only in small quantity, how does the gasoline vapor reach the lamp? The results of the experiments reported in the tables and diagrams above enable an answer to this question to be made with a considerable degree of certainty.

In any carbureter, before the lamps are lighted, the voids of the interior are filled with air at 3 lbs. pressure, at a temperature of 70° to 80° F., which becomes richly charged with gasoline. The gasoline, being very volatile, will charge the air in the deck pipe as well as in the carbureter, for it is to be always remembered that gasoline is not a simple fluid like water, every atom of which has a common boiling point, but a compound fluid, some parts of which have a lower and others a higher boiling point than the mean; besides which, gasoline, like water (only with far greater ease), vaporizes or evaporates at temperatures far below the boiling point. It is the most volatile of liquids with the exception of ether, carbon bisulphide, bromine and one or two rare chemicals.

Opening the needle valve insures a sufficient supply of gas to light the lamps and burn a few minutes by mere expansion. It will also be seen shortly that there will probably be some little condensed fluid gasoline in the air pipes to carburate the air. After lighting, the temperature of the central flue rapidly rises (see line 6, Figs. 45, 46) to 150°-200°. The temperature under the carbureter also (line 3, Fig. 45, lines 1, 4, Fig. 46) rises rapidly to nearly the same point near the center, rising at the top and sides lines 4, 5) much less rapidly.

The carbureter absorbs heat from the current of warm air which circulates around it, and the gasoline inside is vaporized and flows out of both the "air inlet" and the "gas outlet" and thence down to the lamp, together with such air as is needed to make up any deficiency in volume.

To appreciate how small an amount of heat is needed to vaporize all the gasoline which the lamp burns, we must remember in the first place that gasoline is very easily vaporized or condensed, the heat absorbed in vaporization or given off in condensation, being only about one-quarter as much as in the case of water, or 250° to 300° F. On the other hand, gasoline is a somewhat better fuel than coal, being able, pound for pound, to evaporate at least a third more water. Now, the theoretical evaporation of good coal is about 15 lbs. of water per pound of coal = about 60 lbs. of gasoline per pound of coal = perhaps 80 lbs. of gasoline evaporated per pound of gasoline burned. Therefore only 1% to 2% of the heat generated by the flame of the lamp needs to enter the carbureter to keep the lamp continuously supplied with the vapor of gasoline, the amount of heat thus absorbed being the same whether the gasoline be merely vaporized or heated to the boiling temperature. To make the case still more plain, the amount of gasoline burned per hour being about 6 fluid oz. or 4 oz. avoir., the amount of heat required to vaporize it is but little more than would be needed to convert into steam 1 oz. per hour of water, or $\frac{1}{10}$ of a pint.

Evidently this is a very small amount of heat; and if even a small part of the heat from the lamp is circulated around the carbureter it may certainly be expected that the gasoline vapor will be generated faster than the lamp burns it.

But when this occurs—when the heat which the carbureter absorbs per hour, either from the lamp or from the warm air in top of the car, is greater than that needed to evaporate *one-sixteenth of a pint of water*—then the surplus of gasoline vapor will push its way back into the air pipe on the roof of the car. There are 8 to 10 ft. per carbureter of this air pipe, made of thin copper, ⅛ in. in diameter, and exposed to the outside air. Under ordinary circumstances this forms an efficient *condenser*, and in it the gasoline vapor collects in a fluid form. This actually occurred in the experiments above described. (See Table VII.)

But with a hot summer sun shining on the car roof, the copper deck pipe will be a very poor condenser, and the heat of the surplus gasoline vaporized will be greater. Hence there will be no resource for the gasoline steam in summer except to raise the pressure, open the (5 lb.) safety valve and blow through; and if the reasoning so far has been correct, this must take place. It does take place. A considerable loss of gasoline in summer has been observed—just how much we have not been able to ascertain, but enough to lead to experimental efforts to use a heavier oil in summer. It has been ascribed to the direct effect of the sun's heat, and may be in part due to this, but it is more likely to be chiefly due to the cause just suggested.

There are other observed facts, too, which prove the correctness of the explanation of the working of the carbureter system. We will take space to note a few.

In each of the tests reported in Tables VII and VIII the lamp burned for hours together without any air being used at all, which could only have occurred through the gasoline being evaporated faster than it was used by the lamp. In another test made by Mr. PENNIMAN, at Baltimore, in which the plant was set up by the inventor of the carbureter system, the amount of air consumed per hour fell as low as ¼ cu. ft.

Again, in this test 11 oz. of gasoline, or $\frac{1}{10}$ the total amount used, was blown off at the safety valve. In the test made by the carbureter manufacturers the air pipe was cool enough to act as a condenser (see Table VII), and about a quart of gasoline collected in it. This fact alone disposes of the manufacturers' objections that the room in which this test was made was too hot to make the test a fair one.

Still another fact having a bearing on this question was developed in a test of the endurance of the carbureter with different forms of lamp, made by Mr. JOHN D. BOWMAN, Assistant Mechanical Engineer, Pennsylvania R. R. The details of the test are given in Table VI. Mr. BOWMAN says:

> With the Excelsior burner it takes from 20 to 30 minutes in lighting the lamp in a cold car, with the carbureter nearly exhausted, before the carbureter is sufficiently warmed to raise the flame to its normal burning height; when the car is warmed up to about 70° F. and ready for occupancy by passengers, the carbureter will be sufficiently warmed in about 10 minutes with a freshly charged carbureter. However, the flame as soon as lighted can be turned to its normal height, but in 3 or 4 minutes should be turned down a little to prevent smoking.
>
> In lighting up the lamps in a car the flame is at first only turned from ⅛ in. to ¾ in. high, and then as the carbureters become warmed up they creep up to about 1¾ ins. or 2 ins., which is the proper height, without further attention from the trainmen.
>
> With the inverted burner, however, we have observed that the flame when first lighted can be turned at once to its normal burning height (just covering the perforated flame plate). Its tendency is, as the carbureter becomes warmed, to grow whiter rather than to creep up; this is due, we think, to the regenerative principle upon which this burner is constructed.

The explanation of this is that the Excelsior lamp, shown in Fig. 43, heats the carbureter much less than the present inverted type of lamp, Fig. 44, as already explained. Hence there is more condensation in the air pipes with the inverted lamp, and the air which passes to the lamp when it is first lighted is more highly charged with gasoline vapor.

We greatly regret that the manufacturers of the carbureter system have seen fit to withdraw from their promise to furnish us all necessary facilities for making a complete investigation of their system of lighting, thereby blocking the further experiments which had been arranged for. This being the case, however, we have had no choice but to lay the results thus far obtained before our readers, pointing out as plainly as possible their significance and importance. We have briefly summed up the matter in our editorial columns.

Note.—As there has been some conflicting evidence in previous articles of this series concerning the length of time which a carbureter will furnish gas with one filling, a test of this question was made under the immediate charge of Mr. JOHN D. BOWMAN, Assistant Mechanical Engineer, Pennsylvania R. R. The present writer examined the car during this test, and can testify that the whole interior was brilliantly illuminated, though what the actual candle power was it would be impossible to guess, and it was not determined. It will be seen, however, that one of the lamps was of the present form (perhaps with somewhat smaller passages) and yet gave somewhat more hours

of service then the old Excelsior lamp, viz.: 124 hours against 104, whereas the lamp as tested by Mr. PENNIMAN gave only 42 hours' light. There may have been some difference of charging, but allowing 3 galls. to have been burned out in one case and 2 galls. in the other there is the contrast of only 20 hours of light per gallon against 40 hours. On the other hand, other Pennsylvania records show "a quart per hour" for 6 lamps, or 24 hours' service per gallon; but after making all allowances, the contrast indicates that there is a real difference of function, the original Pennsylvania plant burning the oil less rapidly, giving less light and not heating the carbureter so hot. We may note also that a large variety of inverted burners are offered by the carbureter manufacturers, and are claimed to give different amounts of light. A correction should also be made for the gasoline lost by blowing off in the photometric tests, reported in our issue of April 25.

TABLE VI.—ENDURANCE TEST OF CARBURETERS ON CAR NO. 985, PENNA. R. R.

Day.	Date April, 1890.	Time of lighting.		Temperature. Outside of car.	Temperature. Inside of car.	Time of turning off.		Temperature. Outside of car.	Temperature. Inside of car.	Number of hours burned per day.	Total hours burned.
Tues...	15	5	P.M.	54°	51°	10	P.M.	44°	56°	5	5
Wed...	16	11	A.M.			5	"				
		6	P.M.	66	60	11	"	39	44	10	15
Thurs..	17	11	"	66	68	9	"	48	64	10	25
Friday	18	11	"	62	66	8	"	36	62	9	34
Satur..	19	11	"	63	59	9	"	42	61	10	44
Sun....	20	11	"	64	68	9	"	47	67	10	54
Mon...	21	11	"	69	66	9	"	56	73	10	64
Tues...	22	11	"	70	69	9	"	57	69	10	74
Wed...	23	11	"	78	68	9	"	58	70	10	84
Thurs..	24	11	"	58	62	9	"	58	69	10	94
Friday	25	11	"	47	51	9	"	51	66	10	104*
Satur..	26	11	A.M.	44	48	2	"	46	53		
		3.30	P.M.	44	48	6	"	46	53		
		6	"	44	48	10.30	"	46	53	10	114††
Sun....	27	11	"	56	52	9	"	44	57	10	124‡
Mon...	28	11	"	70	66	9	"	52	70	10	134§

* The Excelsior burners show signs of weakness.
† Two Excelsior lamps gave out.
‡ Continued weakness of "Excelsior" lamp. Inverted lamp is also weak.
§ A very fair light from both lights.
NOTE.—This car was equipped with five standard lamps with Excelsior burners and one "inverted" lamp with the Siemens (present form of) burner.

LETTER FROM THE MANUFACTURERS OF THE FROST CARBURETER SYSTEM.

PHILADELPHIA, Pa., July 27, 1891.

ENGINEERING NEWS, TRIBUNE BUILDING, New York City:

GENTLEMEN: Replying to yours of 21st inst. We have read the proofs submitted and regret your decision to publish with such haste the articles, and are astonished to learn that you are not willing to wait until the practical tests are made in service. It is intended that this shall be done as soon as practicable, and we think you are making a great mistake in anticipating the same by publishing the crude information with which you have been furnished from laboratory tests.

We desire to place ourselves on record as objecting to your articles, and when the time comes will answer them in the proper way. Actual experience of cars in service for years past does not sustain the serious defects your articles would convey to your readers.

Again regretting that you have seen fit to use such haste in this matter, without being properly informed on the subjects, we remain, yours very truly,

THE RAILROAD LIGHTING AND MANUFACTURING CO.

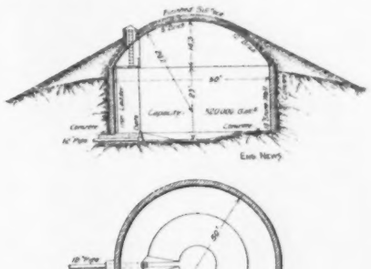
Competitive Tests of Freight Train Brakes in New South Wales.

(FROM AN OCCASIONAL CORRESPONDENT.)

Some important trials of freight train brakes have been recently carried out in New South Wales. Two similar trains, each of 48 four-wheeled freight cars and an eight-wheeled caboose were fitted, one with the Westingbouse quick-acting freight brake, and the other with a quick acting automatic vacuum brake manufactured in Manchester, Eng. The trials embraced stops on a level and on a grade of 176 ft. per mile.

The brakes were also tested on a grade 30 miles long, averaging 108 ft. per mile, and having at the base a 176-ft. grade two miles long. the prevailing grade being, however, 160 ft. combined with 10° curves, reversing without any intermediate tangent. Trains of 35 four-wheeled freight cars, partly loaded, were controlled down this grade very readily. The trains were run as double headers by moguls of English pattern weighing 94,000 lbs. The speed averaged, without stops, about 23 miles per hour, some portions, free from severe curvature, being run at a greater speed. No retaining valves were used by either brake.

These tests down the long grade were intended to test what is known in Australian railroad circles as "the exhaustion theory." Some years ago, a passenger train running down a long grade, got beyond the engineer's control, and as neither trainmen or passengers manned the hand brakes, the engineer was killed and several passengers killed and injured. After the accident, a cock was found shut on the second car behind the engine, but a theory found evidence that this was caused by the telescoping of the cars and that repeated applications of the brake to check the speed round curves on the down grade had exhausted the auxiliary reservoirs and practically destroyed the power of the brake. The fireman



Plan and Section of Covered Reservoir at Coshocton, O.

testified that the engine gage showed 75 lbs. just before the train ran into the river.

The "exhaustion theory," though resting on so slender a basis, has nevertheless, been constantly urged as an argument against the Westinghouse brake. In the recent trials, however, running down the 30-mile grade the pressure in the auxiliary reservoir of rear car rose from 57 lbs. at the summit to 81 lbs. at the foot of the grade, while the rapid rise of the needle of a gage attached to the auxiliary showed that re-charging takes place as fast as the brake is released.

In some experiments afterward made on a train standing in a side track, an endeavor was made to purposely exhaust the auxiliary reservoirs by manipulating the engineer's valve so as to apply and release without recharging. In one case 170 movements, and in another 80 were made before the auxiliary reservoir in the last of 49 cars was reduced to 22½ lbs.

When a skilful man cannot purposely exhaust the brake, the danger of accidental exhaustion, through the ignorance or carelessness of an inexperienced runner, is evidently non-existent.

While the Westinghouse came through the long-grade trials very successfully, the Automatic Vacuum fared badly, for it was discovered at the foot of the grade that the brake shoes on 12 out of the 35 freight cars on the train were "cold as a dog's nose." A descent of nearly 3,000 ft., mainly on 160-ft. grades, would appear to call for every brake shoe doing its duty, but somehow things did not go quite that way, and some of the brethren evidently got discouraged on the way down. The great majority of the idle shoes were in the rear of the train, showing that the action of the brake is not positive on long trains.

A vacuum exists on both sides of the brake piston when the train is running, the lower side of the piston being in direct communication with the train pipe, while the entrance to the top side is guarded by a check valve which enables air to be drawn *from* the top side, but prevents the access of air *to* the space above the piston. In applying the brake, air is admitted to the train pipe, destroying the vacuum beneath the piston. As the check valve prevents the air getting access to the upper side of the piston, the unbalanced pressures applies the brake. The check valve consists of a small brass ball, and should be held off its seat by grit or the air current be too feeble to seat it, the air would gradually leak into the space above the piston and so destroy the vacuum, re-establish equilibrium on both sides of the piston, and so prevent the brake applying. The quick-acting device on the vacuum allows air to enter the train pipe under each car, but as in the quick-acting Westinghouse, it is not operated in graduating.

There was little difference between the two brakes in the length of the emergency stops, but electrical tests made by connecting the indexes of pressure gages in the last car with a chronograph showed that the brake was fully applied to the last car of the Westinghouse train before it had begun to act on the corresponding car in the vacuum train. Some shocks were felt with the latter brake. Both trains were equipped with slack couplings and spring buffers of the usual English pattern, and many couplings were broken during the trials.

Switching trials showed that the Westinghouse effected a considerable saving of time, the vacuum, which has no train pipe cocks, having to be bled directly a car is detached. The release of the vacuum is very slow owing to the absence of any equivalents of a main reservoir and tripple valves.

The engineers' valve on the vacuum comprises a small ejector which maintains a vacuum when the train is running, a large ejector which creates the vacuum to release the brake and a valve for the admission of air to apply the brake, all operated by a single handle. The brake, except as regards the quick-acting valve, resembles that used by many English roads on passenger equipment. The quick-acting device has, however, not been brought into practical use, and the admission of air, often laden with dust, under every car, would certainly appear likely to cause trouble and render the action of the check-valves uncertain.

The Westinghouse is now in very general use in passenger service in Australia, and in one colony, Victoria, it is also used in freight service. The result of the recent trials in South Australia [described in ENGINEERING NEWS, Aug. 1] and in New South Wales, will probably result in the action of Victoria being followed throughout Australia.

The Covered Reservoir at Coshocton, O.

Water-works were built at Coshocton, O., in 1890, and are owned and operated by the village. Water is pumped from driven wells to a circular covered reservoir, 250 ft. above and 9,400 ft. from the pumping station. The village is between the pumps and the reservoir.

A plan and section of the reservoir is given here with. The reservoir has a capacity of 320,000 galls. It is 50 ft. in diameter, 20 ft. deep in the center and a little less at the sides, as shown in the section. The walls are of stone, 18 ins. thick and 21½ ft. high, and the domed roof is of brick, 12 ins. thick, diminished to 8 ins. near the crown. Both the wall and dome are in Portland cement mortar, consisting of 2 parts of sand to 1 of cement. The excavation was made about 8 ins. larger than the outside diameter of the stone wall, leaving a space of from 2 to 6 ins. between the wall and the natural earth. This space was filled with Portland cement concrete. The bottom was also brought to a uniform surface with concrete nowhere less than 4 ins. thick. The roof is covered with earth and sodded.

The center, on which the dome was built, was made of 16 rafters of 2 thicknesses of inch boards nailed together, resting on the skewback. The rafters were braced laterally by inch boards, cut so that the edge of the board and of the rafter were in the surface of the sphere. The frame thus formed was covered with ¼ × 6-in. oak sheeting.

Access to the gate chamber is had through a manhole in the roof, the gate being operated from the level of the top of the walls. A 12-in. main receives and delivers the water.

The cost of the roof was $799, and of the entire scructure $4,310, or about $13.47 per 1,000 galls. of capacity. Dunham & Paine, New York, were Engineers, and we are indebted to them and especially to Mr. C. W. PAINE, of that firm, for the drawings and information given.

The New Water Supply of Newark, N. J.

(*Continued from p. 113.*)

THE MACOPIN INTAKE DAM.

The pipe line and storage reservoirs having been described, the Macopin Intake dam, at the head of the pipe line, will next be taken up.

As has been stated, water will be drawn from the storage reservoirs as needed, and will flow for some distance in the natural bed of the streams. Mossman's Brook, on which Clinton reservoir is located, joins the Pequannock River about 2½ miles from the reservoir, and is about 3¼ miles above the intake dam, while the Oak Ridge reservoir is on the Pequannock River, about seven miles from the intake. The Macopin dam is built across the Pequannock River, and is designed to form a reservoir which will give a constant supply to the pipe line, the 30,000,000 galls. of storage serving this purpose admirably. The dam takes its name from Lake Macopin, the drainage area of which has been secured by locating the intake below the junction of the Lake Macopin outlet with the Pequannock River. Thus the intake reservoir has a drainage area of its own of about 30 sq. miles, in addition to the 48 sq. miles tributary to the Oak Ridge and Clinton storage reservoirs. When the storage reservoirs are full the drainage from the whole area, some 78 miles, passes through the river valley at this point. When the storage reservoirs are not used the flow of the stream is limited to the water derived from its own area, which may be increased by the amounts passed through the gate-houses at the reservoir above.

The Macopin dam has been planned to meet these requirements. Figs. 1 to 7 consist of a plan, elevation and other details of the structure, and Fig. 8 is a general view of the dam during construction, taken after the completion of the overfall and before the main dam had been carried to its full height.

The dam is of ashlar rubble masonry founded on rock. The overfall and main dam are at nearly a right angle with each other, as shown by Fig. 1. The overfall is slightly curved in plan, with a radius of 640 ft. The section of both the overfall and main dam are shown by Figs. 3 and 4, and the junction of the two is shown in plan by Fig. 2. The section of the main dam shows a total height of 38 ft. above rock foundation, or 27 ft. above the natural surface, or at least above the ledge beneath the overfall. The overfall has a height of 22 ft. above the ledge on which it rests, and its crest is 7 ft. below that of the dam. Further details regarding the shape of the sections will be seen by referring to Figs. 3 and 4.

The dam proper has a 10-inch coping, and the overfall a coping irregular in shape, as shown by the section. This coping is made continuous by dowels between the several coping stones, and is secured to the structure by anchors let into the masonry and holding down the dowels every 12 ft.

The arrangement of the gate-house is shown by the plan, Fig. 5, and the sections, Figs. 6 and 7, the latter being a combined section and rear elevation. The dimensions are given on the drawings, and need not be repeated here. The gate-house is of masonry, lined with brick. It is divided by walls into four chambers. Water is admitted to the first two chambers through the portals, first passing through screens. Within each of these chambers there is a double set of screens. The outer screens are made of steel bars, and the inner are of copper wire netting. Five gates control the flow of water to the 4-ft. steel pipe line and the waste pipe.

The gates were made by the Coffin Valve Co., of Boston, and are about 3½ × 4 ft.

At present weir measurements are being made of the flow of the river over a temporary dam placed a few hundred feet down stream from the stone dam.

(*To be continued.*)

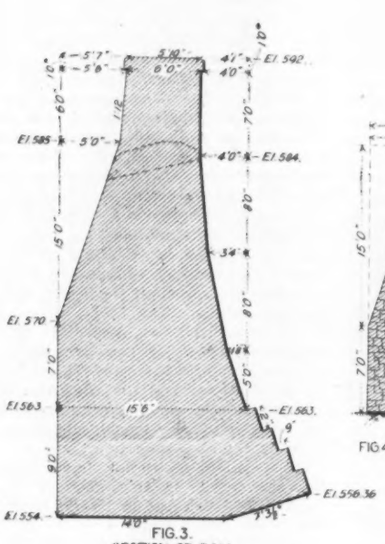


FIG. 3.
SECTION OF DAM.

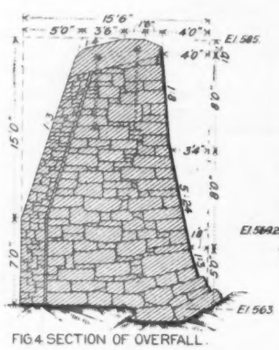


FIG. 4. SECTION OF OVERFALL.

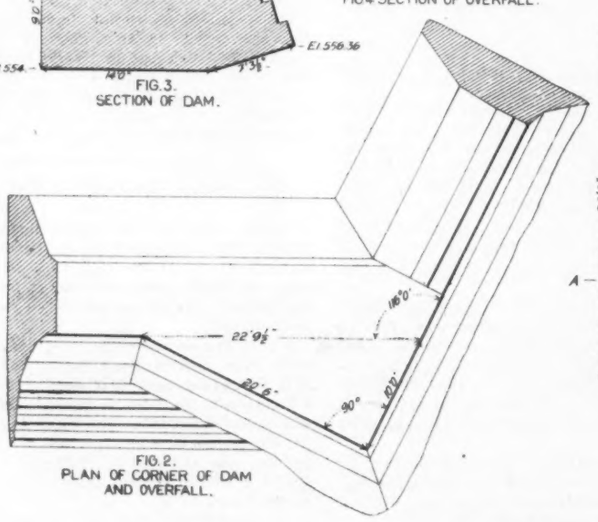


FIG. 2.
PLAN OF CORNER OF DAM AND OVERFALL.

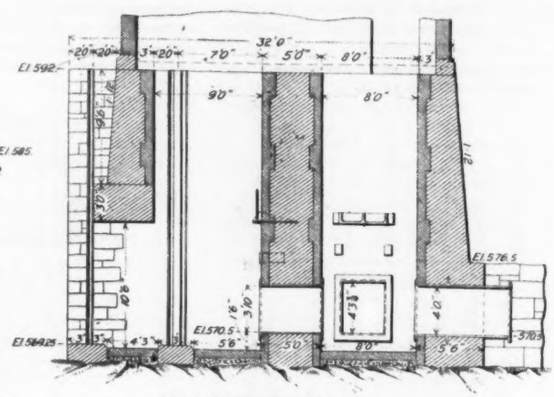


FIG. 6. SECTION ON LINE A - B.

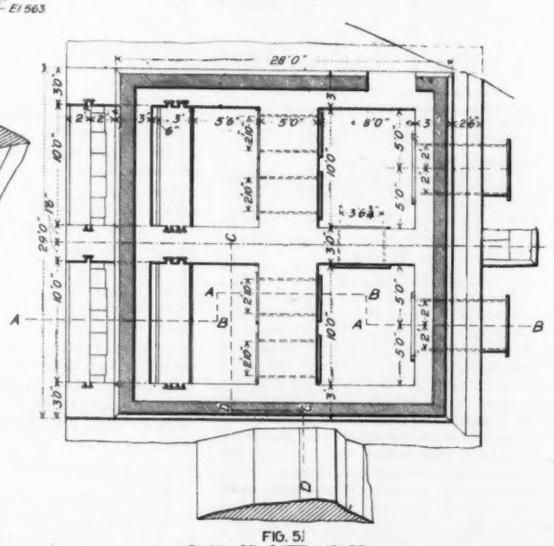


FIG. 5.
PLAN OF GATE HOUSE.

MACOPIN INTAKE DAM.

Street Cleaning in Berlin.

From a report by Consul-General EDWARDS it appears that the expense of street cleaning in Berlin fluctuates greatly on account of the variation in the cost of removing snow in different winters. In 1887-'88, about $154,940 was spent for this purpose, and in 1888-89 about $121,520. Leaving these two severe winters out of account, the other five years of the period covered by the report show only the small natural increase in expenses due to the extension of the street network. The number of men regularly employed in 1882 was 577, and in 1889, 588. As the streets to be cleaned every day increased from about 3,170,000 sq. yds. to about 3,385,000 sq. yds., each laborer was required to clean from 5,500 to 5,750 sq. yds. daily. The number of boys who receive 36 cts. per day for cleaning asphalt increased in the same time from 26 to 76.

In no year was it possible to avoid the employment of supplementary workmen in larger or smaller numbers according to the weather. They were paid 48 cts. per day each. The regular employees received from 60 to 72 cts. each per day and the foremen 84 cts.

The 6 regular overseers received from $514 to $632

a year and their 21 assistants from $357 to $435. Regular employees unfit for duty received pensions of from $95 to $142 a year. The small increase in the number of men regularly enrolled is due to the increase in machine work, 42 sweepers being employed in 1889.

The contractors received $1.43 a day for horse, driver and repairs to machines, the latter item averaging 12½ cts. per day. The cleaning capacity of the machines varies from 6,600 sq. yds. per hour on bad pavement to 10,500 sq. yds. on asphalt. The street sweepings have always been removed by private contractors, who are bound to carry all street filth to the dumping places which are supplied by them. There are also special requirements in regard to wagons, teams, uniforms of drivers, etc.

The contractors are bound under all circumstances to supply enough wagons to remove all refuse each day. The number required varies widely, being occasionally twice as many in wet as in dry weather.

For the removal of snow, separate payment was made, ranging from 42 to 60 cts. per load, and a special check system of management was employed to avoid confusion. Furthermore, the work was so laid out that the principal streets were first cleaned, the removal of snow beginning in the center of the city and extending outward.

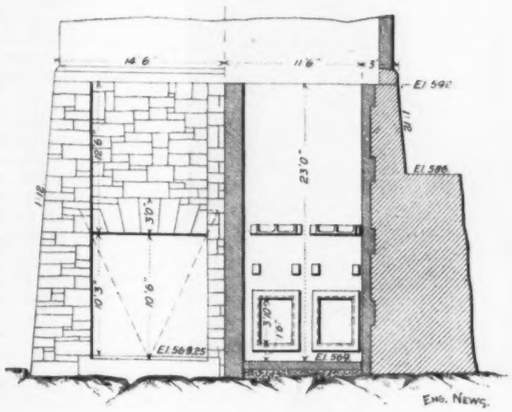
There were 150 sprinkling carts used in 1888-89, the majority containing about 400 galls. The amount paid for sprinkling ranged from $37,100 in 1885-86 to $55,000 in 1887-88.

The street car companies are required to clean and sprinkle their tracks and the street surface on each side for a distance of 2.1 to 2.3 ft. By special contract the city assumed this responsibility, the street car companies paying three-fifths of the actual cost.

The Berlin householders are still responsible for the removal of matter which cannot be admitted to the street sewers and pipes, such as kitchen waste, house sweepings, sand, ashes, broken crockery and other solids. As the growth of the city increased, the possibility of disposing of such substances in a legal manner became constantly more difficult. The contractors for the removal of street filth frequently unloaded such matter on vacant city lots and in parks during the night. Fines did not prevent them from repeating the offense.

Finally the city council decided to establish on land which had previously been rented, three dumping places for such refuse, charging 10 and 15 cts. for each one or two horse load deposited. While this method of disposal is regarded as temporary only, the results so far have been satisfactory.

FIG 1.
GENERAL PLAN.



HALF REAR ELEVATION. HALF SECTION ON C-D.
FIG. 7.

Railways and Railway Tunnels in Wisconsin.*

The topographical slope of Wisconsin is from the northwest to the southeast, and the Wisconsin River has a fall of 900 ft. in its descent to the Mississippi. The two large valleys of the Wisconsin and Rock Rivers are followed, one by the Chicago, Milwaukee & St. Paul, and the other by the Chicago & Northwestern Ry. The elevation of the Rock River valley is 780 ft., and that of the Wisconsin 600 ft. There is at one point a circle of 20 miles in diameter, where the headwaters of several rivers are found, where 6 tunnels are located, having a total length of 2 miles and built at a cost of $700,000.

The ridge elevation at this point is about 1,300 ft. and the contours are quite broken. The tunnels are all in the same geological formation, the St. Peter sand rock, which underlies the Trenton lime rock. This sand rock consists of pure white sand possessing very little cohesion, and is therefore easily worked. A peculiar geological feature of Wisconsin is the fact that, following the country down from northwest to southeast, we have in view the different formations from the first to the present one. Of 26 miles of road at the above-mentioned circle, 21 miles are on a 66-ft. grade. The difficulty of operating is apparent from the fact that a mogul engine with cylinders 18 × 24 ins. can haul only 12 cars.

The Greenfield tunnel, used by the Chicago, Milwaukee & St. Paul, is ¼ mile long, in a very soft portion of the rock. The tunnel had to be timbered and finally it became so unsafe that a new one had to be built 45 ft. from and parallel with the original one. The grade in the new tunnel is only 35 ft. per mile, which is the maximum grade of this road. Working one end at a time, the average progress was 8 3 ft. for 24 hours. The Chicago & Northwestern Ry. has three tunnels, all running on township lines about 6 to 7 miles apart. The longest is 3,810 ft., and was built under Mr. WOODMAN'S supervision. The west approach was very much broken up; both ends were worked and two shafts. One shaft was vertical, 75 ft. deep, and the other on a slope 135 ft. long. Considerable trouble was caused by water, the tunnel passing through a regular artesian-well region. Two shifts of 11 hours were worked.

The average progress and quantities taken out in the three tunnels were as follows:

	Progress.	Quantities.
No. 1	53.7 ft. per week.	13.96 cu. yds. per ft.
No. 2	32.0 " " "	12.64 " " " "
No 3	21.7 " " "	11.2 " " " "

A bonus was offered in No. 3 to pay the miners $5 for every foot made over 33 ft. per week, and the progress was thus advanced to 42 ft., as against 21.7 ft. The greatest progress in No. 3 was 51 ft. per week in soft places.

Generally the heading was squared in three rounds. First, 3 foot holes were excavated, then 3 main holes and then 3 top holes. The area of a section was about 12 sq. yds.

The drillers could be heard 270 ft. distant. Only hand drills were used. No 3 was estimated at 11.1 yds. per ft. and all three were designed to be of the same dimensions

The contract price in Nos. 1 and 3 was $4.30 per yd., and in No. 2 $3.75. No reason for this last price except the guesswork of the contractors. No. 3 cost every cent that was paid for it. In 1872 the contractor wanted to quit, but the company guaranteed to pay him $10 per yd. for the remaining 10,000 yds., and yet he had no profit. The actual average cost was $5.79 per yd. and at that time the average cost of hard rock tunnels in the United States was $5.89. At that time, out of 300 tunnels, only 12 were longer than No. 3.

The following figures relate to tunnels built in the vicinity referred to:

	Length.	Cost per ft.	Total cost.
West Wisconsin	881.5 ft.	$43.01	$37 913
New Greenfield	1,230 "	60.54	85,518
No. 1, C. & N. W	1,694 "	58.44	98,971
No. 2, " "	1,594 "	47.40	75,557
No. 3, " "	3,810 "	64.90	247,272

A flat car with frame on was run through to test dimensions. The average dimensions were 16 × 19 ft. clear. Once a year the tunnels are generally examined and loose stuff shaken down. The shafts were filled up. Tunnel No. 2 was lined while in operation. Iron centers were used, made of rails on 3 ft. centers, using 16-ft. lagging. Four brick rings were put in.

Three different rigged flat cars were used to do the lining—one for the footing and lower wall, one for the intermediate portion and one for the top. The ventilation was toward one end or the other, according to the directions of the wind.

The discussion on the paper was short, and brought out the fact that the best way of ventilating a tunnel of the length of No. 3, is to run a train through quickly and follow it up with another.

Fig. 8 Macopin Intake Dam, Overfall Nearly Completed.

* Abstract of a paper by Mr. WOODMAN, read May 8 at a joint meeting of the Engineers' Clubs of St. Paul and Minneapolis.

The Mersey Tunnel for the Liverpool Water-Works.

The interference by the Liverpool Board of Trade with the plans of Mr. G. F. DEACON, the engineer of the Liverpool Corporation for the supply of water, has resulted, as these things usually do, in trouble and a lawsuit. Sir JOHN HAWKESLEY'S original plans for crossing the Mersey River with the water supply from the Vyrnwy reservoir contemplated a tunnel in the old red sandstone at from 104 to 170 ft. below the water surface. Mr. DEACON, later, proposed to lay the pipes in a trench dredged in the river, a method that promised the least trouble and expense and could have doubtless been successfully completed long ago. But the Board of Trade would not have this and insisted upon a tunnel.

As a result Messrs. Monk & Newell, in April, 1888, contracted for £19,000 to build a tunnel under the river on specifications prepared by the Engineer of the Corporation. They worked about 20 months; but the character of the work was so different from what they expected and progressed so slowly and unsatisfactorily that the corporation took possession of the plant and material in Dec., 1889, and later re-let the work to Messrs. COCHRANE for £15,235. After allowing for work done and plant and material on the ground the new contract exceeded the cost of the first by £9,000.

Messrs. Monk & Newell, the original contractors, now sue for: Work done, £16,940; loss of profit by reason of work being taken from them, £11,000; detention of plant, £525. The Corporation sets up a counter-claim of £9,000 for the increased cost under the new contract, and the case is now before Sir JOHN COODE, President of the Institution of Civil Engineers, as an arbitrator, and has not yet been settled.

The contractors contend that under their contract they undertook to drive the tunnel through impervious material, and the specifications and information from borings presented led them to believe that such material existed. They expected to find a bowlder-clay formation with at least 6 ft. of impervious material between the crown of the tunnel and the overlying stratum. It turned out, however, that the impervious bed of clay did not exist, and the only method possible was to drive the tunnel through sand by means of compressed air. As a consequence they claim the difference in cost.

The Corporation contends that the specification did not guarantee bowlder-clay, and contained the words, "or other impervious material," and that by the wording of the specifications the contractors were to take the whole of the responsibility regarding the soil through which they had to go. These specifications also provided for a shield to be used during construction, showing that the engineer contemplated meeting with water-bearing strata. As remarked, the case has not yet been decided. It seems, however, that the Messrs. Cochrane are also having trouble, and though their contract was to be completed by the end of 1890, they have so far got to a depth of only 140 ft. with their shaft.

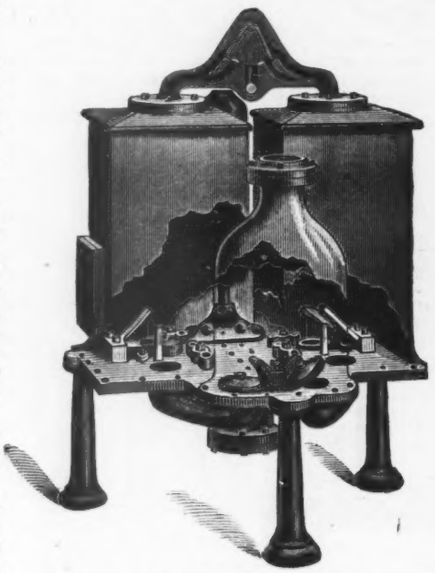
THE NEW SIMS-EDISON TORPEDO was lately officially tested at Willet's Point. This torpedo is driven, steered and discharged by an electric current transmitted through 2¼ miles of highly insulated cable. It can carry 1,500 lbs. of dynamite, weighs 5,000 lbs., is 31 ft. long and 25 ins. in diameter. The cost is $12,500. In the test it traveled 12,000 ft. in 6 minutes, or at the rate of 20 miles per hour, and answered perfectly the steering signals. It turned and came back to the starting point. The trial is said to have been eminently successful.

STREET-CLEANING BY FLUSHING FROM THE HYDRANTS is to be tried in some of the dirtiest streets on the east side of New York City. Screens are to be attached to the catch basins to prevent dirt from entering the sewers, and the streets are to be swept as clean as possible before the flushing is done.

AN ELECTRIC LOG has been patented and is now being tested by the government. Its peculiar feature is its claimed ability to register high speeds, a purpose for which the present patent log, long in use, is worthless.

An Improved Steam Vacuum Pump.

A steam vacuum pump has been invented and put upon the market by Mr. GEORGE E. NYE, of 76 Washington St., Chicago. As will be seen by reference to the cuts given, there are simply two cast-iron chambers, with a condenser attached to



View of Nye Pump Showing Valve.

the rear, a simple, balanced automatic steam valve on top, and four common clack valves covering the suction and delivery ports. The whole pump is raised on three supports, and, while occupying little space, is easily and quickly set up.

Its operation is as follows: With the pump in position and the ordinary connections made the condenser is filled with water and the pump is ready to start. Steam is then admitted to one of the chambers to dispel the air, and it is then turned off. This steam is at once condensed by a jet or spray of water passing into the bottom of the chamber, and a vacuum is formed which allows the atmosphere to force

Perspective View of Nye Pump

water into the chamber from below through the suction pipe.

The peculiar feature of this pump lies in the steam valve, which has a face in the form of a segment, with a rounded top portion coinciding substantially with a seat on the inside of the crown of the case. The segment bounded by the inside lines of the crown of the case has greater longitude than the segment valve, whereby the latter may be swung to open or close either of the ports, and thereby allow steam to pass to either chamber. In continuing the description of the working of the pump in connection with the valve, the effect of the vacuum made has been conveyed by a port to one end of the sensitively balanced steam-valve, and this moves gently toward the vacuum, shutting the steam ports to that chamber and opening those to the other. Steam is again turned on and enters the second chamber and the same operation repeated. The valve is actuated automatically by the steam pressure and is not moved by the vacuum, as in other vacuum pumps, and this is considered the most important and distinctive feature of the pump.

The inventor says that these pumps will throw from 50 to 100 galls. of water per minute, and with live steam they will raise 75,000 galls. of water 20 ft. high with 100 lbs. of coal. They can also pump water containing from 40 to 60% sand, etc. The advantages of the absence of pistons, packing, etc., are obvious to the user. They are made in 8 sizes, ranging from 50 to 5,000 galls. per minute. Further particulars may be learned by addressing the inventor as above given.

PERSONALS.

Mr. W. W. WILSON, for some years Master of Machinery of the Chicago & Alton R. R., died at Chicago, Ill., Aug. 9.

Mr. W. F. POTTER has been appointed General Superintendent of the Flint & Pere Marquette R. R., vice Mr. SANFORD KEENE, resigned.

Mr. J. D. BRODBECK, of Omaha, Neb., who served several terms as City Engineer of that city, and also as County Engineer, died recently.

Mr. OSCAR SANNE, consulting engineer, of Milwaukee, Wis., has been appointed assistant engineer of the World's Fair to Mr. GOTTLEIB, of Chicago. He retains his office at Milwaukee.

Mr. W. B. W. HOWE, JR., Chief Engineer of the Savannah, Florida & Western Ry., and Charleston & Savannah Ry., has severed his connection with the Plant system.

Lieut. ROBERT E. PEARY, of the Greenland expedition, was at Godhaven, on Disco Bay, Greenland, on June 29. He was then to sail immediately for Upernavik, which is about 73° N. Latitude, and the most northerly of the Danish settlements.

The Hon. Sir HECTOR LOUIS LANGEVIN, K. C. M. G., and Canadian Minister of Public Works, has resigned his office owing to the late scandals in the department which he controls. Sir HECTOR himself seems to have had no part in the division of spoils from contracts, but his son is named as one who has benefited thereby.

Mr. JAMES P. NELSON, Chief Engineer of the Newport News & Mississippi Valley Ry., has been appointed to the chair of Civil Engineering and Physics of the Kentucky State College, at Lexington, Ky. He formerly conducted the scientific course at Kenyon College, Gambier, O., and is a graduate of the Washington and Lee University.

Mr. RICHARD COLTS SHANNON, of New York and Maine, and late Secretary of Legation to Brazil, has been appointed Minister to Nicaragua, San Salvador and Costa Rica under the new act of Congress authorizing a Minister for these countries. Mr. SHANNON is said to be a good Spanish scholar and his appointment is thus contrary to our traditions in such appointments, where as a rule, the one thing the Minister does not know is the language of the people to whom he is sent.

MR. ROBERT E. MCMATH, M. Am. Soc. C. E., for years Sewer Commissioner of St. Louis, has opened an office, in connection with his sons, as a consulting engineer in all branches of municipal engineering. As many growing towns, and even cities, do not maintain a regular engineer organization, but have need of the stated or occasional services of an experienced engineer, there should be a wide field for consulting engineers of the standing of Robert E. McMath & Sons.

NEW PUBLICATIONS.

August Magazines.—The literary magazines this month are pretty much given up to light reading supposed to be appropriate for the vacation season. *Scribner's* is called a

fiction number, and the only things in it aside from fiction are a description of scenes in Picadilly in the series on the great streets of the world, and a second article from Mr. JOHN H. WIGMORE on the new political era in Japan, which deserves much praise.

In *The Century* GUSTAVE KOBBE describes "Life on the South Shoal Lightship" anchored off Nantucket, a sort of existence about as monotonous and uncomfortable as can be imagined. "Our Summer Migration," by EDWARD HUNGERFORD, is a study of the effects produced by the summer exodus from the cities to the country. The article has considerable interest, but the serious ignorance of economics which the author betrays in figuring up all the expense of the summer touring as a benefit to the country at large impairs one's confidence in his ability to discuss his subject.

The two articles in *Harper's* of most interest to engineers are a paper on New Zealand, finely illustrated and a criticism of Western Architecture, by MONTGOMERY SCHUYLER. The latter paper is the first of a series, the city whose buildings are discussed in this number being Chicago. Chicagoans are not especially thin skinned, but they are proud of their architectural wonders, and will probably resent Mr. SCHUYLER'S searching criticisms. Of the City and County Building he says that "it combines the dignity of a commercial traveler with the bland repose of St. Vitus . . . one would go far to find a more perfect expression of anarchy in architecture."

In the *Popular Science Monthly* the valuable series on the evolution of the manufacture of wool, to which we have before alluded, is concluded. CARROLL D. WRIGHT contributes a paper on the value of statistics, in which he shows very plainly that their value depends almost entirely on the statistician. "The value of any statistical presentation must depend on the basis on which it is made, the integrity of the collection of its various elements and the analysis which accompanies it. No one has any right to use statistical tables without quoting and understanding the analysis of them." Another article of engineering interest is an address delivered by F. W. CLARK at the recent Patent Centennial on "The Relations of Abstract Research to Practical Invention." He urges greater co-operation in all lines of scientific research as the surest means to increase our rate of progress in the arts and industries.

The Forum has a paper by SIMON STERNE describing the "Greathead Underground Electric Railway" (the City & South London Electric Ry., the tunnel of which was driven by the Greathead system), which we have criticised elsewhere. The NANSEN polar expedition is discussed by the explorer himself and by Gen. A. W. GREELY, as described in our issue of Aug. 1.

The North American Review is well supplied with articles of technical interest. Assistant Secretary of the Navy SOLEY contributes a paper on the value of naval manœuvres and describes the mimic wars by which the British Navy is trained every summer. He urges that some sort of naval manœuvres should be begun with the handful of vessels which we now have, and that the scope of these exercises should be enlarged as fast as the growth of the navy will permit. Another article of interest to marine engineers is by LEWIS HERRESHOFF on "Possibilities of the Steam Yacht." He shows that future gains in speed are likely to be made only by careful attention to a multitude of small details, the object being always to reduce the weight without reducing the power. At the present time a yacht can be built which will maintain a speed of 28 miles per hour for a 5-hour run, and the author thinks it within the bounds of reason to expect that steam yachts having a speed of 35 miles per hour will be no un common thing by the close of this decade.

The reduction of weight attained in the best yacht engines will be news to many engineers. The compound engines of the *Stiletto* weigh 10 lbs. per I. HP. The engines of the U. S. torpedo boat *Cushing* are quadruple expansion of 1,600 HP., and weigh 15 lbs. per I. HP. The entire motive power machinery of the *Cushing* weighs 65 lbs. per I. HP., while that of the *City of Paris* weighs about 200 lbs.

Two papers of less importance than those above named discuss respectively the proposed consolidation with New York City of its suburbs within the State limits, and the rain making experiments of Gen. DYRENFURTH. The writer of the latter article, whose faith in the rain makers is admirable, explains that the moisture is not shaken out of the clouds by the explosions like walnuts out of a tree, but "the effective cause is the sudden condensation of the air from a reduction in its own temperature. The heat generated by the explosions of gunpowder, oxyhydrogen gas, etc., great as it is, is utterly insignificant in comparison with the cold produced by the sudden expansion of their gases." This astonishing bit of thermodynamics ought to make its author famous.

A word of reference must also be made to an article by Prof. R. H. THURSTON on "The Scientific Basis of Belief.' Criticism of the article itself would be out of place here, but many engineers will doubtless be interested in reading an article on a subject of such absorbing interest at the present day, prepared by an engineer who has made for himself a reputation as an intelligent scientific thinker on subjects outside of his profession.

—*Annual Report of the Chief of the Bureau of Steam Engineering for* 1890. GEO. W. MELVILLE, Engineer in Chief. Washington, 1891, Government Printing Office. Paper, 6 × 9 ins., pp. 77; 49 folding plates.

The plates which accompany this report show the machinery designed for several of the important vessels of the new navy now under contract. The lack of any index to these plates, however, is a great inconvenience in referring to them.

The report itself, although brief, contains much matter of interest and value. The experimental work reported is exceedingly interesting, especially the report on the trials of coil or tubulous boilers which resulted in the approval of the boiler designed by CHARLES WARD, of Charleston, W. Va. Boilers of this type are to be placed in the new coast-defense vessel *Monterey*. Tests were also made on the strength of manganese bronze and on the best form of steam jet for launch boilers.

The report on the trials of the *Baltimore*, *Philadelphia*, *San Francisco* and *Vesuvius*, which is given very fully in tabular form, shows that those vessels are fitted with efficient machinery.

The *Baltimore* averaged one indicated HP. for each 1.71 sq. ft. of boiler heating surface in her 4 hours' run under forced draft. Chief Engineer MELVILLE thinks it by no means certain that any of the new ships have shown the best results of which they are capable.

In the matter of steel castings the navy seems to be particularly unfortunate, perhaps because blow-holes are so rigidly excluded. Mr. MELVILLE says, "Unless there is a very great improvement in the making of steel castings, and in a very short time, a return to cast-iron will be inevitable." The project for establishing at the League Island Navy Yard a thoroughly efficient plant for building and repairing vessels and machinery is again urged. This project was described and illustrated in our issue of Nov. 23, 1889.

The fact that with all the new ships with complicated machinery being added to the navy, no steps are taken to properly man them with engineer officers is again commented on as follows: "We not only need a very much larger number of officers in the Engineer Corps, but we also need a very much better course of instruction for the young men who are each year appointed into it."

The modern war vessel is an enormous and complicated mass of machinery. Admiral LUCE, in a recent work on "Naval Training," says that to take a modern ship to sea the services of but two men are necessary on deck, one at the lead and one at the steam steering wheel. The fact that the efficient handling of all this machinery requires men properly trained in every grade, from coal-passer to chief engineer, is too obvious to be disputed.

—*The Trackman's Helper*, by J. KINDELAN, Mitchell, South Dakota, 1891. Published by the author. Cloth, 4½ × 7½ ins., pp. 364. Second edition, revised and enlarged, nearly 100 pages added, with new illustrations and tables. $1.50.

This little book is intended for the instruction of section foremen, and those who aspire to become section foremen, in the ordinary duties required of them. The author is a roadmaster on the Chicago, Milwaukee & St. Paul, and has had experience enough to enable him to write a very practical and useful book. The various chapters are entitled New Road, Spring Track Work, Summer Track Work, Frogs and Switches, Curved Tracks, Fall Track Work, Winter Track Work, General Instructions, Miscellaneous. There is a full table of contents but no index, and the general arrangement of the matter is not above criticism. We see that the author recommends placing track jacks on the outside of the rail when surfacing, citing the Quincy accident of a year ago as a reason. Under "How to do Work," we note the following:

"If you have only dirt for ballast don't always be telling what good track you could have with gravel or rock, but see how good a track you can make with dirt for a ballast." In another place the author reveals his knowledge of how things go, as follows:

"All railroad companies are more liberal when constructing than they are when the road is in operation; and if a company lays their own track the man in charge of the work should see that it is done well, even if the cost is greater."

We might criticise many things which the author says, and cite some omissions which he makes, but on the whole we are more inclined to praise him for the work he has done. There are other books on maintenance of way which will be of more value to a young engineer in that department; but for the instruction of section foremen we are inclined to accept the author's statement that it is superior to any book heretofore published.

—*Report on the Substitution of Metal for Wood for Railway Ties;* E. E. RUSSELL TRATMAN, A. M. Am. Soc. C. E.; with a Discussion on Practicable Economies in the Use of Wood for Railway Purposes, by B. E. FERNOW, Chief of the Forestry Division, U. S Department of Agriculture. Pub. Doc., Washington, D. C. Size, 5¾ x 9 in.; pp., 350; plates, 30.

This is the second edition of Bulletin No. 4 of the Forestry Division, the first edition of which was reviewed in our issue of Aug. 30, 1890. The first part of the report gives detailed descriptions and particulars of the experience with numerous forms of cast-iron, wrought-iron and steel ties on railways in all parts of the world. Tables of mileages are given for the several countries, with the following tabular summary:

Percentage of Metal Track Mileage.

Section.	Total m'tal track.	Total track.	Percentage of metal track.
	Miles.	Miles.	
No. 1. Europe.....	10,232	132,071	7.74
No. 2. Africa.....	1,230	5,202	24.80
No. 3. Australasia..	186	10,640	1.75
No. 4. Asia.....	9,315	19,106	48.75
No. 5. So. and Cent. America, Mexico..	3,788	19,461	19.46
No. 6. North America	2	174,165	.....
West Indies.....	.....	1,241	.....
Total.....	24,803	361,886	6.85

Total mileage of railway with metal track 24,800
Total mileage of railways of the world (exclusive of United States and Canada,..... 187,721
Percentage of railway with metal track (exclusive of United States and Canada,..... ..... 13.21%

The second part of the report is devoted to a general review of the metal track question, dealing with the material, form, size, thickness and weight of ties; merits of different styles of fastenings; arrangements at frogs and switches, etc. The uses of steel ties for rack railways, military railways and street railways, and of light steel ties for light and portable railways, are also dealt with. The conclusion arrived at is that while no general or extended movement can be predicted in this country within the near future, there has been a marked advance within the last year or two, which advance appears likely to continue, and that it is highly probable that the use of metal ties for railways, as a substitute for wooden ties, will become one of the live problems of railway economics.

What is Forestry? B. E. FERNOW, Chief of Forestry Division. Bulletin No. 5, Forestry Division, U. S. Department of Agriculture, Washington, D. C. Paper 5¾ × 9 ins., pp. 52.

This pamphlet is an interesting addition to the literature on the forestry question—a question which is receiving more and more attention in this country, largely through the work of the Forestry Division. Part 1—The Forest and its Significance. Part 2—Forestry in a Wooded Country or Forest Management. Part 3—Forest Planting in a Treeless Country. Part 4—Experiences in Tree Planting on Dakota Plains.

Bulletin de la Commission Internationale du Congrès des Chemins de Fer. Brussels, Belgium. Vol. 4; Nos. 4, 5, 6.

This number contains an obituary of the late M. FASSIAUX, President of the Commission, and an interesting paper on "Uniform Standard Time," by M. DE BUSSCHERE, Engineer-in Chief of the Belgian State Rrailways. The paper begins by a general consideration of the question, and then refers to the situation in different countries, including a reference to the work done in this country and Canada by Mr. SANDFORD FLEMING, and a copy of the bills presented to Congress in January, 1891, and to the Canadian Parliament.

—*Sixteenth Annual Report of the Chamber of Commerce of Portland, Oregon.* T. F. OSBORN, President; D. D. OLIPHANT, Secretary. Portland, 1891. Paper, 6 × 9 ins.; pp. 111 and xxx. With statistical tables.

The population of Portland, according to the recount by the U. S. census authorities, is 72,357; and it has 72¼ miles of street railway lines, operated almost wholly by steam, cable or electrity. There are also 14½ miles projected for construction during the present year. The total cost of buildings erected during the year was $3,448,600. The total amount expended in street improvements was $268,170.

—*Poor's Manual of Railroads*, New York, 1891; H. V & H. W. Poor; cloth, 6 × 9 ins.; XXII + 1437; 30 maps; price $6.

We have already reviewed the advance pages of the introduction to this issue of the "Manual."

—*Municipal Engineering*—What it is and when needed. R. E. McMath, M. Am. Soc. C. E., St. Louis, Mo. Pamphlet, 5¼ x 7½ in., pp. 7.

TRADE PUBLICATIONS.

—*Phosphor-Bronze Price List.* No. 8, 1891. Phosphor Bronze Smelting Co., Philadelphia, Pa.

Pamphlet, 5½ × 3½ ins., pp. 20. Prices of sheets, wire nails, bolts, etc., and tables of weights.

—*Catalogue of Contractors' Supplies.*—Ryan-McDonald Mfg., Co., Baltimore, Md. Paper, 7½ x 9¾ in., pp. 48.

This catalogue contains illustrations and descriptions, with prices of parts, etc., of dump cars, locomotives, hoisting plant, boilers, and other contractors' plant.

—*Dials.*—A trade pamphlet issued by the Thomson Meter Co., of New York, treating of the change in the registering dials of water meters as adopted by that company. The interesting part of this little publication are published extracts of letters voting for and against the change, as written by users of meters and those connected with water-works.

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COMING TECHNICAL MEETINGS.

Engineers' Society of Western Pennsylvania.—Aug. 18. Secy., J. H. Harlow, Pittsburg, Pa.

New England Roadmasters' Association.—Annual Convention, Aug. 19, 20, Boston. Secy., G. L. E. French, Northampton, Mass.

Engineers' Club of Cincinnati.—Aug. 20. Secy., J. F. Wilson.

Scandinavian Engineering Society of Chicago.—Aug. 20. Secy., T. G. Philfeldt, 113 Adams St.

Engineers' Club of St. Louis.—Sept. 2. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Western Society of Engineers.—Sept. 2. Secy., J. W. Weston, 280 La Salle St., Chicago.

Engineers' Club of Minneapolis.—Sept. 3. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Sept. 4. Secy., E. K. Smoot, 803 Commerce St.

Technical Society of the Pacific Coast.—Sept. 4. Secy., O. von Geldern, 819 Market St., San Francisco.

American Society of Swedish Engineers.—Sept. 5. At 250 Union St., Brooklyn, and 347 North 9th St., Philadelphia.

Civil Engineers' Society of St. Paul.—Sept. 7. Secy., C. L. Annan.

Engineers' Club of Kansas City.—Sept. 7. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—Sept. 8. Secy., Parker N. Black, Room 39 Capitol Block.

Denver Society of Civil Engineers.—Sept. 8. "Municipal Engineering." Secy., Geo. H. Angell.

Civil Engineers' Association of Kansas.—Sept. 9. Secy., J. C. Herring, Wichita, Kan.

Civil Engineers' Club of Cleveland.—Sept. 11. Secy., A. H. Porter, 50 Euclid Ave.

IT is one of the facts of human experience difficult to be accounted for, that the public often shows a disposition to prefer advice from amateurs to advice from those experienced in any given profession. Amateur doctors, lawyers and preachers frequently secure a large following; but the public seems to pay greatest respect of all to amateur engineers. An instance of this is found in the last number of *The Forum*, where a respected lawyer and financier, Mr. SIMON STERNE, tells what he thinks he knows about the "Greathead Underground Electric Railway." Mr. STERNE is a keen observer and a ready writer, and almost everything he says of the Greathead system is true; but, unfortunately, he is not an engineer, and the few mistakes into which his amateur knowledge leads him are all the more likely to deceive the reader who is not an engineer, because of the straightforward style and the evident knowledge with which the author writes.

Mr. STERNE describes the defects of the old London underground railway, the seepage through the masonry lining and the noxious gases due to the use of steam locomotives. He tells of the Greathead tunnel with its water tight cast-iron lining and its electrically propelled trains making no smoke or gas, and he says: "There is a consensus of opinion, in England at least, that the solution of the question of rapid transit for cities has been found." He describes the Greathead system of tunneling in the following lucid manner: "The tunnel is circular, is driven through sand, clay, gravel or rock, by instruments specially devised for the purpose." Farther on he describes the shield, the principal feature of the Greathead system, and tells how it is pushed forward "by six or eight hydraulic presses; its sharp edge cutting away another eighteen inches of the material to be displaced." Evidently the author supposes that the "hydraulic presses" are able to push the shield through any material, from adamant to quicksand. It is at this important point that he makes his mistake. The Greathead system of tunneling, as every engineer knows, is intended only for the penetration of soft materials which cannot be excavated with safety and economy by ordinary methods. In the excavation of a tunnel through rock, a Greathead shield would be useless. As for the cast-iron lining on which Mr. STERNE lays much stress, it is an enormously expensive adjunct of the system, and should be used only when the nature of the material penetrated is such as to require it. This is a matter which can be determined only by a competent engineer making a careful examination of the material.

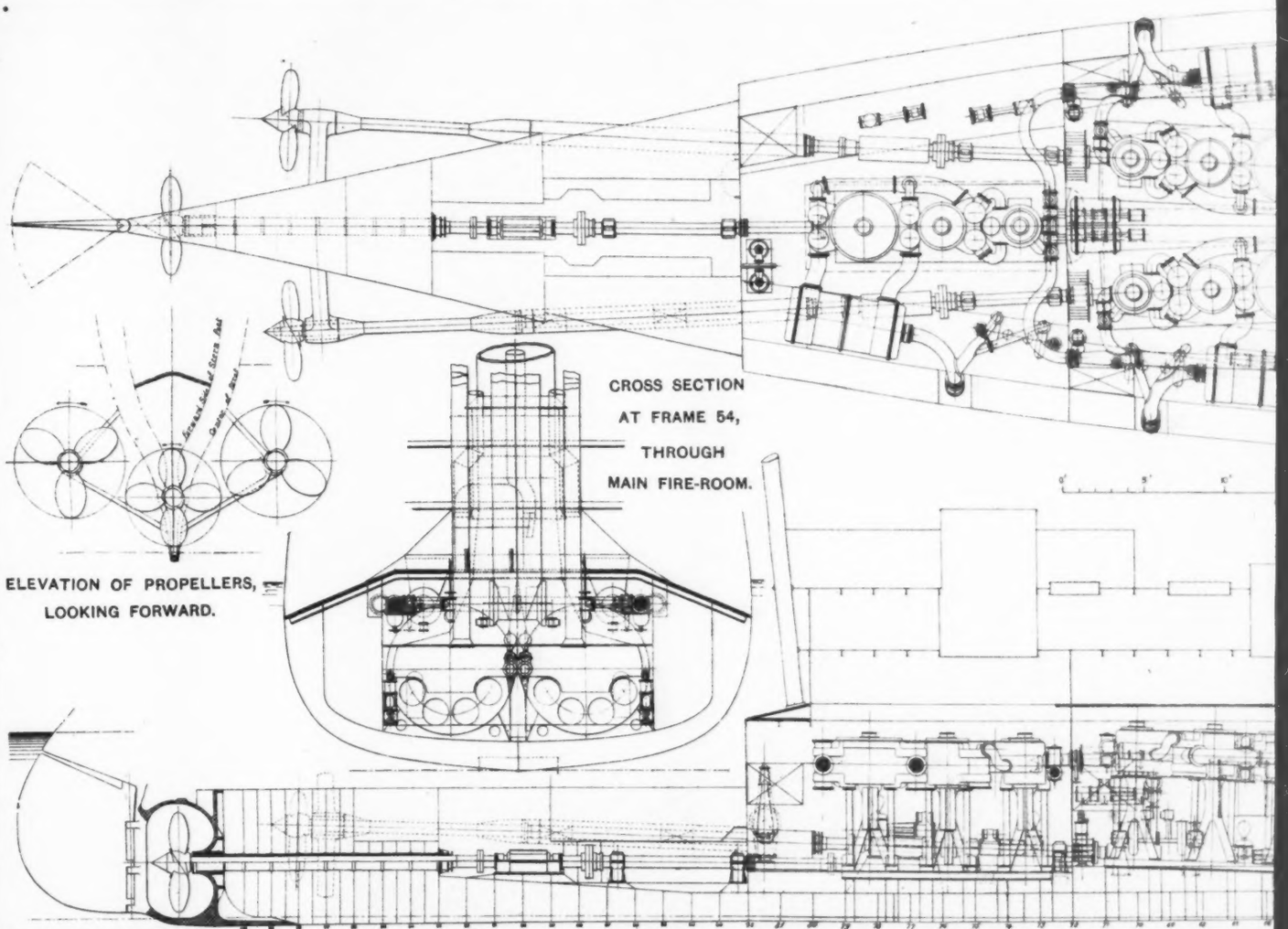
OF course the moral which Mr. STERNE seeks to draw from the success of the Greathead system in London is that, "it is the best adapted for purposes of rapid transit on Manhattan Island." Somebody has indeed suggested to him that the system is ill adapted to the rock that underlies New York north of Fourteenth St.; but this he characterizes as "a misconception" and concludes by saying, "There is, therefore, nothing in the nature of the material on which New York City stands which in the slightest degree interferes with the adoption of the Greathead system of tunneling." What the word "therefore" in the above sentence refers to, the author fails to reveal.

It is to be sincerely hoped that this paper of Mr. STERNE'S, published in a magazine with the standing of *The Forum*, may deceive none of the influential men whose friendship and co-operation are needed in the scheme of rapid transit now being worked out for New York City. To tunnel through rock by the Greathead system would be not merely unwise but totally impracticable, a fact of which any one may satisfy himself by studying the description of the plant used at the St. Clair Tunnel (the greatest work yet accomplished under this system) as described in the series of articles in our last volume.

Mr. STERNE'S mistake is the very common one of amateurs in every profession—assuming that what works well in one case will work well in another totally different. There are valuable lessons to be learned from the success of the Greathead railway; but the use of a shield in driving a tunnel through rock is not one of them.

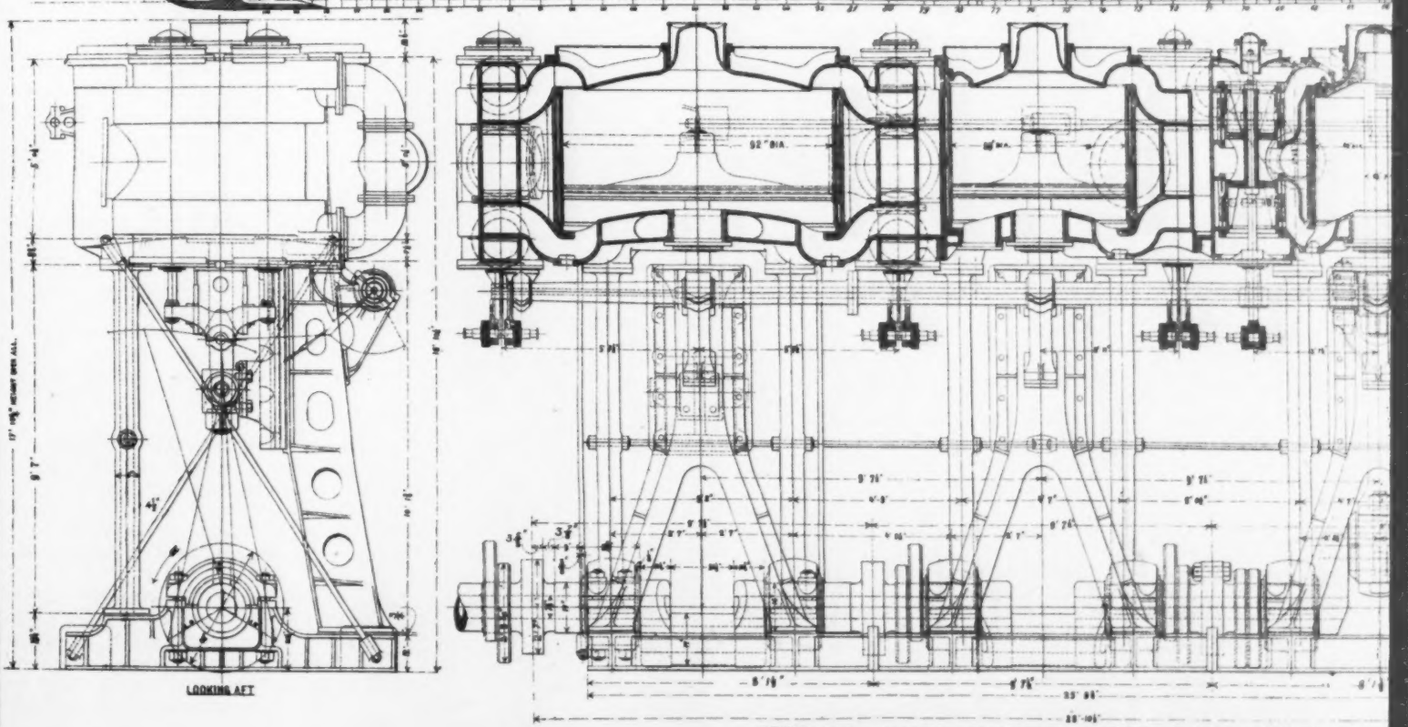
IN the present controversy over the Mersey tunnel for the Vyrnwy water supply for Liverpool, England, noted elsewhere, there are several points worthy of comment. The first is the wisdom of the Lord Chief Justice, Sir CHARLES RUSSELL, in deciding that this was not a case for a jury or ordinary law judges; and he very properly appointed an engineer of eminence, no less a man than the President of the Institution of Civil Engineers, as an arbitrator. This is an excellent example that could be followed with profit in many cases that come before our own courts. Engineering experts, as witnesses in the case, are not always sufficient; that full justice be done to both parties, the judge also should be an engineer, of the widest experience and soundest judgment attainable. The second point is the result of interference by a board of trade with the plans of an able engineer who has carefully studied the situation and is best able to judge of the comparative merits of contrasting plans. In this case there was little or no chance for failure in pipe laying in a dredged trench, and the cost would have been comparatively small and easily estimated. But by forcing a tunnel on the engineer, a tunnel through very doubtful material, the cost of execution has been raised enormously, and the feasibility of the tunnel plan is not yet assured after some years' trial and a reletting of the work. The present suit between the contractor and the corporation turns upon the too common specification clause demanding of the contractor a bid that is equivalent to his gambling upon a certain utterly unknown sequence of events. If the soil, that borings usually fail to disclose in its material arrangement, turns out to be one thing, he makes money; if it happens to be something else, he loses. It is a pure chance; and it seems to many unjust to require the contractor, who is only an agent in the execution of the work, to take this chance. But the contractor is an "adventurer," as the old term had it, just as is every man engaged in commerce or trade. A manufacturer of any article may turn out an abnormal output in the expectation that there will be a demand for it; or the financier may invest largely in certain enterprises with the assurance that values will rise. Both may win largely; but both may be wofully deceived in their diagnosis of the market and lose, just as the contractor loses when he makes a wrong guess. It is a "business chance" all must take; though the case of the contractor is one that may demand adjudication before an engineer-judge, as in the case above.

THE government rain-makers are now at the point in Texas selected for their experiments, equipped with balloons, kites, dynamite and electric batteries, and we may shortly expect some considerable racket, if nothing else, from that neighborhood. Even if rain does follow this demonstration it will take a series of experiments extended over a considerable length of time to prove the theories advanced. While we admit that in the summation of many experiences Mr. EDWARD POWERS, C. E., in his "War and the Weather," makes out a very good case for his record of battles in the Civil war and the rain which followed, some of these records can be criticized. We happen to have some knowledge of the case he cites for Bull Run battle. This was fought on July 21, 1861, in a bright, clear day, but was followed by a drenching rain next day. Now, we have the best of authority for saying that at Charleston, S. C., the day of the battle was signalized by a terrific rainstorm coming from the South, and at ordinary rates of travel



CROSS SECTION AT FRAME 54, THROUGH MAIN FIRE-ROOM.

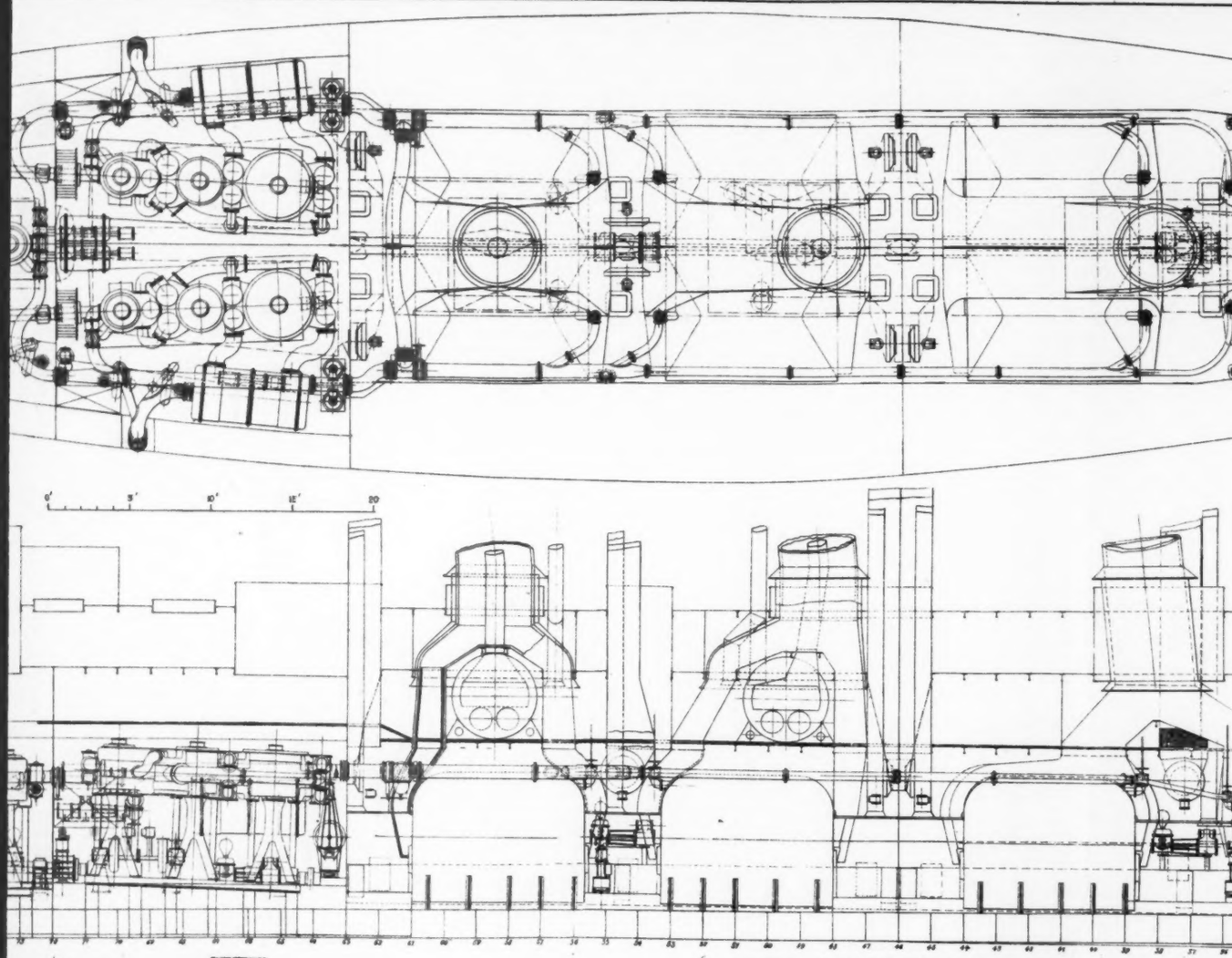
ELEVATION OF PROPELLERS, LOOKING FORWARD.



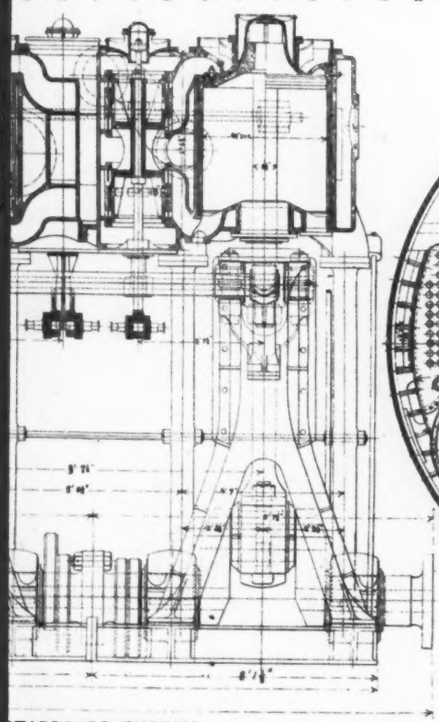
LOOKING AFT

SECTIONAL AND END ELEVATIONS OF STARBOARD ENGINES.

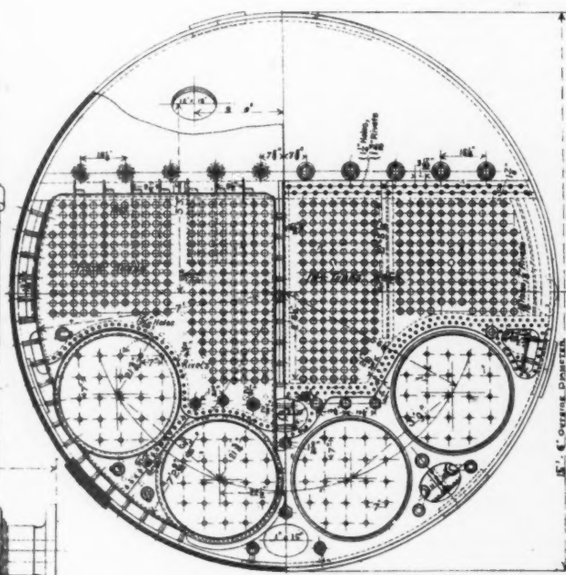
PROPELLING MACHINERY FOR PROTECTED CRUISER, No. 12, U. S. NAVY.

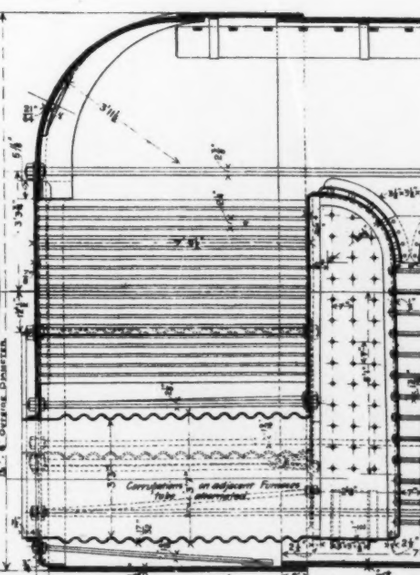


GENERAL ARRANGEMENT OF MACHINERY.



STARBOARD ENGINES.

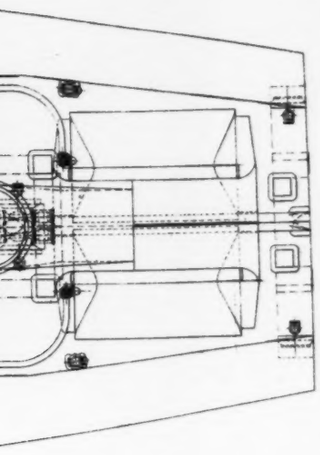


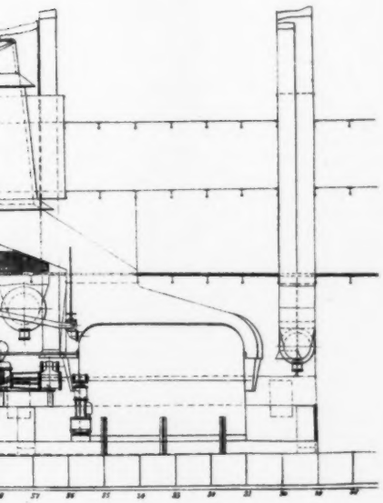


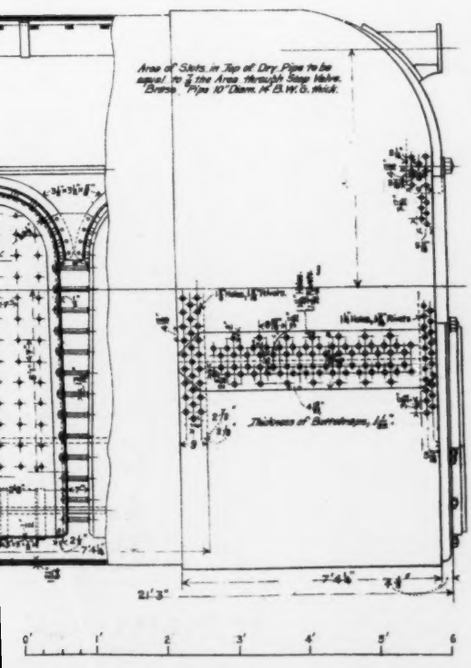
MAIN BOILERS.

CRUISER,

TRIPLE SCREWS DRIVEN BY THREE TRIPLE-EXPANSION ENGINES.
TOTAL DISPLACEMENT, 7350 TONS. I. HP., 21,000.
TOTAL HEATING SURFACE, 43,269 Sq. Ft.







ES.

LITH. CHAS. HART & SONS, 24 VESEY ST. N. Y

this storm would have reached Bull Run on the day following, even if so much powder had not been burned. Of course, this is but one case out of many, and can not be taken as a proof that the other cases mentioned had a similar origin. But we have little doubt that if we had modern weather bureau records covering the period referred to, other cases of battles followed by rain could be traced to other causes than the explosion of gunpowder. There is seemingly a law of chances that favors the periodicity of rain storms, and they have certainly followed battles. But we very much doubt that any artificial agitation of the atmosphere possible by man will necessarily bring on a rainstorm. The field of operations is a little too wide to be sensibly effected by the insignificant agents man can bring into action.

Tests of the Frost Dry Carbureter System of Car Lighting.

Elsewhere in this issue we conclude our description of the Frost dry carbureter system of car lighting, the publication of which has been for some weeks interrupted by causes explained elsewhere.

The tests whose results we now make public were made in the factory of the Railroad Lighting & Manufacturing Co., the first by the company's mechanical engineer and the second by Mr. W. B. D. PENNIMAN. The results of the tests were surprising to all parties concerned, inasmuch as they indicated that the working of the system was in some essential features very different from what had heretofore been claimed.

A considerable amount of evidence has accumulated, moreover, tending to confirm the results of these experiments; and to show that under some circumstances at least the carbureter system of lighting is a very different mechanism from what has been supposed. To make this matter plain we will briefly state the theoretical working of the carbureter heretofore stated and accepted, and also its actual working according to the evidence elsewhere given.

(1) *The theory has been* that the gas burned in the lamp was a mixture of air and gasoline vapor produced by passing air under 3 lbs. pressure through the carbureter, which is a copper case filled with cotton wicking saturated with gasoline. *The experiments have shown* that at times the gas burned in the lamp is pure gasoline vapor, no air passing through the apparatus at all, while at all times the quantity of air used is less than has heretofore been supposed.

(2) *The theory has been* that the gasoline contained in the carbureter was not heated above 70° to 80° Fahr., except by the passage of heated air through it; in one form of the plant, the air circulating around the heater being supposed merely to keep it warm. *The experiments have shown* that the gasoline in some parts of the carbureter is heated to 119° Fahr., which is the boiling point of gasoline under 3 lbs. pressure. Of course it could not be heated hotter without increasing the pressure.

(3) *The theory has been* that the deck pipe was a mere passage for air to the carbureter. *The experiments have shown* that it probably serves also as a condenser, to take care of the surplus gasoline boiled out of the carbureter by the lamp; and hence generally contains more or less liquid gasoline.

(4) *The theory has been* that the "by-pass" opening permits the passage of only about 10 per cent. of the air used. *The experiments*, so far as we have been able to have them made, indicate that at times all the air used and a considerable part of the gasoline vapor passes through this orifice.

These are certainly important differences, and most, if not all, of them will, we believe, be news to each and every person interested in the plant, either as inventor, manufacturer or user. We will admit that not a single one of them was known or suspected by us until some time after we began this investigation. Two of them at least we did not know of or suspect until very recently; in fact, not until some time after the writing of this series of articles had been begun.

The natural questions which arise at once are first as to the correctness of the above results, second as to the influence which they may have on the safety of this system of lighting.

The first of these questions is answered in the description of the tests and experiments elsewhere given in this issue. If the tests there reported are not absolutely conclusive as to the working of the system, the evidence they furnish is certainly sufficient to warrant the demand that the investigation shall not be stopped at this point.

As one result of the investigation started by us, one of the chief railways using the Frost system has already taken steps to insure that the gasoline in the carbureters on *its* cars at least shall not be boiled. We can hardly doubt that the carbureter manufacturers themselves will make radical changes in their plant, although at this time we are not aware that they have taken any steps in this direction.

It is also true that no positive evidence, pointing to a lack of safety in use, has been deduced from the investigation so far made. But the unexpected results of these experiments are of such a character that the manufacturers owe it to themselves, and to the public they serve, to continue them on even a broader scale; and judging from their original position in inviting the fullest investigation and criticism, this they no doubt will do.

The nature of gasoline is such that a full knowledge of its behavior under all conditions of use is of vital importance, and in this statement we know we echo the sentiments of all users of this fluid in car-lighting practice, and feel that the manufacturer, from pure business motives, if nothing else, will not expose his plant, invested capital and reputation to any defects in the system that can be remedied by a still more searching inquiry into its behavior.

We began this inquiry at the risk of having our true motives misinterpreted; it has cost us time and money and has been the basis of some more or less disagreeable correspondence. But we felt that we had a duty to perform at the time, and now believe that our efforts have resulted in certain discoveries, unexpected though they were, that will have an important bearing upon rendering this system safer than it was before, by reason of certain changes of form that will doubtless be made. We publish fully the experiments made, the conditions under which they were made, and the position taken by the manufacturers of this system; and leave our readers to decide for themselves the questions discussed.

The Titles and Duties of Engineers.

Several of our correspondents have lately brought up the old question of titles of engineers on construction and maintenance of way. Practically speaking, an exact definition of duty and responsibility is much more important than the mere question of title, and, in our opinion, no fast rule can be made for all cases in this connection, though much can be done to improve upon present practice. A short line of a few miles in length may have upon it half a dozen very important engineering structures, requiring more technical knowledge and experience in the engineer in charge for their successful execution than fifty miles of railway located over easy ground. Even the title of chief engineer conveys nothing more than that for that particular work, be it great or very insignificant, he is the man at the head of its engineering and is responsible for its character. The same rule holds good for each succeeding grade below the chief, no matter by what title the engineer may be designated.

One of the very best authorities on the important questions of the duties and responsibilities of the several grades of engineers, is MR. WILLIAM F. SHUNK, one of the oldest and best known of our railway engineers, and a man who has made a special and careful study of the organization of engineering parties. MR. SHUNK, in his "Regulations" for the engineering department of the South Pennsylvania Railway defines the various grades and duties of the engineering staff on construction substantially as follows:

Chief Engineer; with exclusive engineering control.

Consulting Engineer; without executive power.

Associate Engineer; next in authority to the chief, and in general charge of all classes of engineers and engineering work.

Division Engineer; having charge of the construction of about 30 miles of road, with work divided into sections of about 1 mile and subdivisions of from 6 to 10 sections.

Principal Assistant Engineer, in charge of special work, such as important structures, the compilation of records, the preparation of plans, etc. When such charge falls within the territory of a Division Engineer, the Chief or Associate Engineer will exactly define the limits of responsibility and expect hearty co-operation.

Resident Engineer, appointed by Division Engineer with approval of the Associate Engineer, and subject to removal under like conditions. The Resident Engineer can appoint or remove his subordinates, subject to the approval of the Division Engineer. The duties of the Resident Engineer and the amount of work under his charge are defined by his immediate superior, the Division Engineer. The Resident Engineer's immediate subordinates are a rodman competent to handle a transit or level, tapemen and axemen.

These excellent "regulations" proceed to closely define the duties and methods of the several officers in detail too extended for further comment here. But the noticeable feature throughout is the exact definition of duty and responsibility. As will be remarked, the term Assistant Engineer is wholly omitted, and the Principal Assistant Engineer ranks with the Division Engineer, and is assigned to special duty. This is the best gradation of officers and titles therefor, for construction work, that we have seen.

The requirements for the officers engaged in the maintenance of completed railways are somewhat different, but some effort should be made to systematize what is now a woful mixture of official titles. The present practice differs widely throughout the country. On some roads the General Manager is also the Chief Engineer; other roads have a Chief Engineer for all new work and an Engineer of Maintenance of Way to look out for all finished work; other roads still have no regularly employed engineering staff, but depend upon independent engineers hired by the day for a special piece of work. Leaving out this last specimen of railway management as one to be particularly condemned, and assuming that the railway is of sufficient importance and sufficiently well organized to have a Chief Engineer of its own, we can discuss the titles of the officers subordinate to the chief. It would seem to us that the terms Division, Principal Assistant and Resident Engineers, as defined by Mr. SHUNK, would apply to all roads of sufficient length and importance to warrant such a distribution of staff. But there are cases of unusually long divisions, as much as 300 and 400 miles in length on the Canadian Pacific, for example, where there is a Division Engineer, but no Resident Engineer in the strict sense of that term. All engineers subordinate to the Division Engineer are sent out from the division headquarters on

special assignment of duty, and as they are men necessarily of some experience in engineering and have fixed responsibilities, the term Assistant Engineers would seem to fit their duties better than that of Resident, as they do not reside on their sections of work, and, in fact, are liable to be called to duty anywhere on the division. These assistants are properly staff officers of the Division Engineer. On the Pennsylvania R. R. the subordinate to the Division Engineer is entitled Supervisor, and he performs the duties of the old roadmaster and does such engineering work as he may fall heir to on his particular section. He is a resident engineer in the sense that he resides upon his section of work; but his special duty is the maintenance of way and general control of the men engaged in that work. He must however, be a civil engineer, and is in the direct line of promotion to all the engineering positions above him.

There is another class of engineers that seemingly need a title especially their own—the engineers who are sent out each with an independent party in making the preliminary surveys for important work covering a large area of country. Each of these engineers is subordinate only to the Chief, or to an Associate Chief Engineer. They are not in charge of any special division, for they may be shifted from one location or class of duty to another at any time, and they certainly are not resident engineers. For this class of men the title of Chief-of-party has been used, and this we think is better than that of Engineer-in-charge, employed by others.

Uniformity in the official title of engineers is especially desirable, but to each title there should also be attached some recognized duty and limit of responsibility. It is confusing, to say the least, in official correspondence to discover that one officer who signs himself an Assistant Engineer, is the equal in rank and official position to another officer who signs himself a Division Engineer, as in the case noted by our correspondent in this issue. Reform in this direction would reach much further than the mere form of the title. If properly carried out, based upon some established and recognized gradation of duties to be performed, it would fix responsibilities, lead to better discipline, and give to the holder of the title a recognition in his official world that would be as nearly fixed as these values can be fixed on roads differing widely in importance. It is a subject worth some study and discussion by those interested, and we should be pleased to hear from engineers upon the present practice in this particular on the trunk lines they represent.

CORRESPONDENCE.

A Question of Street Grades.

SEATTLE, Wash., Aug. 4, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: An ordinance in this city reads: "There will be a uniform and continuous rate of grade in the streets between each and every two adjacent streets, intersections or points named in this ordinance."

A dispute as to the interpretation of this section of the ordinance has arisen between the engineers and a certain prominent lawyer here. The engineers claim, to illustrate, that with two streets running parallel, but crossing another street at different elevations (say elevations 300 and 303), the difference in elevation divided by the distance between the adjacent margins of the parallel streets will give the true rate of grade, and that this will fulfill the wording of the ordinance. The lawyer claims that such is not the case, and that a curved grade, essentially a vertical grade, between the two points will meet the requirements, provided this is susceptible of being accurately fixed, so that it may be replaced at any time. Please let us have your opinion through ENGINEERING NEWS and oblige A SUBSCRIBER.

[The engineers are right. We would like to see the lawyer apply his vertical curve under the circumstances usually controlling street grading.—ED. ENG. NEWS.]

Titles of Engineers.

DALLAS, Tex., Aug. 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR—The communication signed Chief Engineer in your issue of July 26, in regard to titles belonging to the various grades of responsibility on engineering work, is to the point. There should be some standard adopted by general consent, from which an idea may be formed of the duties and responsibilities pertaining to the position to which a title is applied.

On three of the trunk lines in Texas, the Southern Pacific, Texas Pacific and International Great Northern, the General Managers are virtually Chief Engineers, and their principal assistants are termed Resident Engineers, the jurisdiction of the latter extending, I believe, over the entire lines, and the lesser positions are filled by assistant engineers, who report to the Resident Engineers. On the Gulf, Colo. & Santa Fé Ry. the principal assistant is titled "Assistant Engineer," and his assistants Resident Engineers, the reverse of the above.

On construction of new roads I believe the common practice here is to term the engineer who has direct charge of the work, Assistant Chief Engineer, and his assistants, who attend to sections of 5 to 15 miles, Division Engineers.

While the authorities cited in the communication of "Chief Engineer" are certainly good, it seems to me that an engineer who is in direct charge of 50 to 100 miles of construction, or of the engineering work of an operated road, and whose office and residence is fixed, is properly a Resident Engineer, and his assistants who have divisions of this territory should be termed Division or Assistant Engineers—the one in charge of a party on survey being Chief of Party. However, the matter is conventional, and I hope will be generally discussed, and some system agreed upon and adopted on railway work.

As to Government work, it is idle to discuss a system for that until Congress shall create a corps in which merit and ability and not seniority or West Point graduation or army service will regulate rank and title.

ASSISTANT ENGINEER.

Maximum Panel Shear for Uniform Moving Load.

POTTSTOWN, PA., July 25, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: To some of your readers who are familiar with the form $\frac{mp}{2(n-1)}$ (the constant occurring in the equation giving maximum shear in the panel for uniform moving load), and who have never had occasion to look into its derivation, the following proof may be of interest:

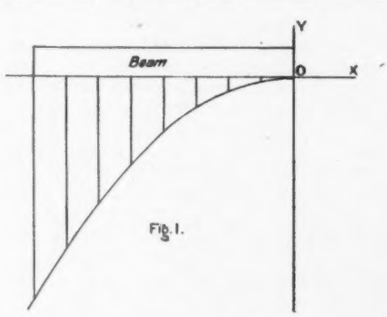


Fig. 1.

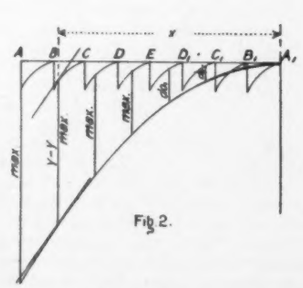


Fig. 2.

As a uniform load moves on to a beam from the right (Fig. 1), the shears generated are proportional to the ordinates of a parabola whose origin is at the right end of the beam. Since this is true for any kind of a beam supported at the ends, it is just as true for a panel (whose supports are the adjacent panel points) as it is for the whole span whose supports are the abutments; and we have the panel shears represented by ordinates to the small parabolas (Fig. 2).

Now, as the ordinates show (Fig. 1) the shear at any point is greatest when the beam is fully loaded *up to that point*; but the greatest shear in the panel, $B\ C$ (Fig. 2), will effect the web member as such only when applied at the panel point C. Thus, from the theory of shear, the weight due to the portion of the load left of C must be deducted from the total reaction; that is to say, that the maximum shear in the web member of panel $B\ C$ will be represented, not where the ordinate to the large parabola is greatest, nor where that to the small one is greatest, but where the *difference* between these two ordinates is a maximum. Obviously, this difference is a maximum at the point where the two curves have the same direction, *i. e.*, where tangents to these curves at the same ordinate are parallel. If, then, we have the equation for the large curve

$$y = \frac{mx^2}{2l} \qquad (1)$$

where y = the ordinate,
" x = distance from O toward left,
" m = load per ft.,
and l = length of span in feet;
and for the small curve

$$y_1 = \frac{mx_1^2}{2p}, \qquad (2)$$

where y_1 = the ordinate,
" x_1 = distance from C to left,
" m = load per ft.,
and p = panel length,

we can put the first differentials of each equal to one another, and find that value of x for which tangents to the curves are parallel.

When r = the number of panels to the right of the panel in question, $x_1 = x - rp$. Making this substitution in equation (2) we have

$$y_1 = \frac{m(x-rp)^2}{2p}. \qquad (3)$$

From (1) we have

$$\frac{dy}{dx} = \frac{mx}{l}, \qquad (4)$$

the direction of the tangent to the large curve; and from (3)

$$\frac{dy_1}{dx} = \frac{mx}{p} - mr, \qquad (5)$$

the direction of tangent to the small curve.

Equating the second members of (4) and (5) we find $x = \frac{lpr}{l-p}$; and remembering that $p = \frac{l}{n}$, we have

$$x = \frac{rl}{n-1}, \qquad (6)$$

where n = the number of panels.

Subtracting equation (3) from equation (1) we have

$$y - y_1 = \frac{m}{2}\left[\frac{x^2}{l} - \frac{(x-rp)^2}{p}\right].$$

This, after substituting for x its value in equation (6), and giving to l its value np, gives us

$$y - y_1 = \frac{r^2 mp}{2(n-1)}, \qquad (7)$$

the true value for maximum shear in any panel, there being r panels to the right of it. It will be seen that this value varies with r^2 only.

Yours truly, WM. W. CREHORE.

Notes and Queries.

J. F., Baltimore, Md., inquires as to who can make surveys in New York State, and what is the law controlling signature to plat for registration?

[We have no law for the State of New York at hand. In the City of New York surveyors are appointed by the Common Council, and the appointment is approved by the Mayor and an oath is taken by the appointee before the Clerk of the County Court "to well and truly perform the duties of his office." No examination as to fitness is required, and—if the surveyor can get work—his signature is valid for registration. If the state law is as loose in this particular as that for the city, which dates from 1793, the signature of any one signing as "surveyor" should be good in law, for any one can obtain the legal authority to sign. The only check upon the present form of the law in New York City is that a comparatively few old and experienced firms of surveyors monopolize all the business worth anything; and no others are employed by those who wish to feel secure in work done.—ED. ENG. NEWS.]

A POWDER CHARGE OF 440 LBS. was, for the first time in this country, used in the trial of the 12 in. gun, at Sandy Hook, this week. The attempt is now being made to adapt a powder to the projectile, muzzle velocity and chamber pressure of the new gun. The powder used in the previous tests was a German prismatic and too quick in its action. The powder last used was made especially by the Du-Ponts, and was not quite strong enough, and further trials will be necessary. The gun is designed to fire a 1,000-lb. shot with 440 lbs. of powder, with a resulting muzzle velocity of 1,950 ft. per second and a pressure not exceeding 35,000 lbs. per sq. in. The result of the full charge was 1,792 ft. and a pressure of 34,440 lbs.

Duplex Compound Locomotive, St. Gothard Ry.

The accompanying cut, from an autotype sent us by Mr. J. A. MAFFEI, of Munich, gives a good idea of the large compound locomotive of the Mallet type, recently built by Herr MAFFEI for freight service on the heavy mountain grades of the St. Gothard Ry. The builder was required to produce a locomotive which, with the same boiler pressure, 177 lbs., and the same weight as the regular eight-coupled engine and tender of that line, would give the same efficiency with less fuel consumption. At the same time it was desired to have the new engine run more smoothly than the old form.

The eight-coupled locomotive had a rigid wheel base of 12.8 ft., while the compound has a rigid base of only 8.85 ft. and can consequently follow the many curves of the Gothard line with less sliding and less danger of derailment. The compound system is easily carried out in this case, as on other Mallet compound engines of similar design. The rear (high pressure) cylinders are rigidly connected to the main frame, which carries the three rear axles, while the front pair, which are for low pressure, are so attached to the movable forward truck that the steam connections are easily made, especially since they work with the low pressure of 50 lbs. With this pressure there is little difficulty in connecting the two pair of cylinders and still less in connecting the exhaust pipe with the blast nozzles.

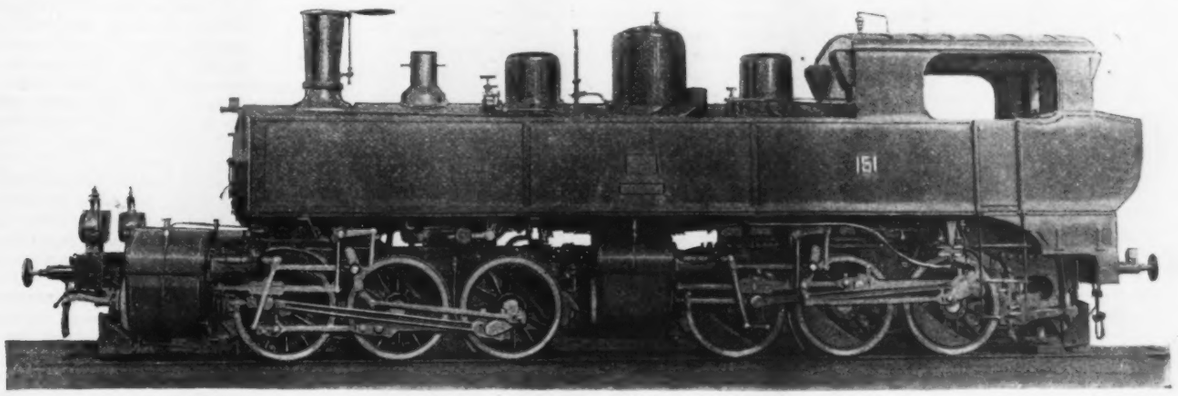
By adopting the tank form of engine a greater adhesion is of course produced than would otherwise be the case, and as a starting valve is provided, so that the high pressure exhaust can be directed into the air or low pressure cylinders at will, while live steam can be admitted into the latter, it is possible to start easily with the maximum train load on the steepest grade, that is 220 tons exclusive of the locomotive, on a grade of 2.6%.

The symmetrical distribution of weight and steam on both sides of the locomotive ensures an easy riding machine. The boiler is rigidly attached to the main frames at the rear, and rests on the forward truck on two cast-iron slides moving in oil, which are carried on rocking supports firmly attached so the frame of the truck. In order to insure a quick return to the proper position in passing from curves to tangents, a set of springs is placed in a horizontal plane, while the inequalities of the track are overcome by a series of longitudinal and transverse equalizing levers. The engine is fitted with the Exter emergency brake and the Hardy vacuum brake working on 8 wheels, having one shoe on the outer side of the two outer wheels of each group.

An interesting comparison of the different sizes of three existing Mallet compound locomotives is given in the following table. The engine of the Swiss Central Ry. was built by Herr MAFFEI, and has 8 wheels, while the *Tom Pouce* is one of the little engines, also with 8 wheels, which attracted so much attention on the Decauville line, of 24-ins. gage, at the Paris Exposition of 1889.

DIMENSIONS OF THREE COMPOUND LOCOMOTIVES; MALLET SYSTEM.

	Tom Pouce.	S. C. Ry.	St. G. Ry.
Cylinders, diam., h. p.	0.61 ft.	1.16 ft.	1.31 ft.
" " l. p.	0.92 "	1.80 "	1.90 "
" stroke	0.85 "	2.10 "	2.40 "
Wheels, diam	1.97 "	4.19 "	4.03 "
Wheel-base, each group	2.80 "	.....	8.85 "
" total	9.20 "	21.30 "	26.70 "
Length over buffers	17.70 "	35.50 "	45.20 "
Boiler pressure	177 lbs.	177 lbs.	177 lbs.
Heating surface, fire-box	25 sq. ft.	87 sq. ft.	100 sq. ft.
" " tubes	215 "	1,164 "	1,564 "
" " total	240 "	1,251 "	1,664 "
Grate area	5.3 "	19.6 "	23.7 "
Water	2,980 lbs.	11,000 lbs	15,400 lbs.
Coal	1,100 "	4,400 "	9,500 "
Weight, empty	20,500 "	106,000 "	154,000 "
" loaded, max	25,600 "	131,200 "	190,000 "
Tractive power	3,970 "	.....	21,400 "



DUPLEX COMPOUND LOCOMOTIVE, MALLET SYSTEM; ST. GOTHARD RY. J. A. Maffei, Builder.

The above description, taken mainly from the *Schweizerische Bauzeitung*, presents practically all the information respecting the St. Gothard engine which has yet been made public by the builder or by the officers of the railway; but we hope to present later a detailed account prepared from information obtained from official sources. The small compound engines of the Mallet "articulated" system have been described in ENGINEERING NEWS of Sept. 1, 1888, and June 1, 1850.

Irrigation and Irrigation Systems in San Bernardino County, Cal.

BY F. C. FINKLE, C. E.

(Continued from Page 119.)

THE BEAR VALLEY RESERVOIR.

The Bear Valley dam and reservoir as now constructed have a storage capacity sufficient to supply water for the irrigation of about 18,000 acres of land. The reservoir is well located for distributing water to any part of the San Bernardino Valley. Being situated at the head of Bear Creek, which is a tributary of the Santa Ana River, the waters can be allowed to flow in the cañon and taken out at any elevation desired, from which elevation conduits can be constructed to the lands designed to be reached. In the past and at present, the waters of the reservoir have been used only to supply Redlands and vicinity with domestic and irrigating water.

The Redlands Colony was founded by the same men who built the Bear Valley Reservoir and one was intended for the other, there being, originally, no intention of taking the water from Bear Valley to any place except Redlands. Therefore the dam was built to impound enough water for the Redlands Colony only, being made of sufficient capacity to allow a good margin in dry years. The present dam has a height of 53 ft., and the lake is now about 5½ miles in length, and has an average width of ⅝ miles. According to the official map of the Bear Valley Reservoir it has a capacity sufficient to supply 65 cu. ft. of water per second for 6¾ months, or 111 cu. ft. per second for four months.

[For description views of dam under construction, plan, elevation and section, together with editorial comment, see ENGINEERING NEWS, vol. XIX., pp. 271, 513. Also, for matter and illustrations regarding proposed new dam, 120 ft. high, see vol. XXII., pp. 484, 512.—ED. ENG. NEWS.]

So much has been written regrading this structure that it is unnecessary to describe it further, except to repeat that the dam is built of masonry, laid in Portland cement, and has a width at the base of 8½ ft. and on top of 3½ ft.; also that it is curved and relies upon the arch principle for strength instead of having a gravity section.

While no reliable engineer will say that the Bear Valley Dam is entirely *unsafe*, I do not for one believe in advocating the construction of such a dam where permanency is sought, or where there is danger of damage to life and property by its giving way.

Since the present dam has proved such a successful enterprise, and the colony of Redlands nourished by its waters has showed such marked results, the owners of the reservoir have begun to look around for other similar enterprises. They had no difficulty in finding lands where water was needed, and lands which are within easy reach of the Bear Valley Reservoir.

The only obstacle was that the amount of water which could be spared from the reservoir in its present condition is not sufficient to warrant the starting of any large irrigation enterprise with that as a basis. But surveys have been made to ascertain in what way and to what extent the capacity of the reservoir can be increased, and the conclusion arrived at is that by constructing a new dam, 80 ft. high, the capacity of the reservoir can be increased four times, and more in proportion by building the dam still higher.

Plans have already been prepared for a dam 120 ft. high, which it is intended to build only to a height of 80 ft. at present, leaving it in such a condition that it can be raised higher when needed.

Many persons who are acquainted with the water sheds of Bear Valley claim that it is useless to build such a large dam, because there is not water shed enough to fill the reservoir which it would create. That there is not a sufficient water shed directly tributary to the reservoir is undoubtedly beyond dispute; but the engineers of the company who have made surveys of the water sheds report that there are other water sheds which can be made tributary to that of the Bear Valley by artificial means. They claim that by constructing catchment basins and artificial channels, or canals, from these into Bear Valley, a reservoir can be kept filled up to the 120-ft. contour. Not having any personal acquaintance with the feasibility of this project and never having seen any report of such surveys which would establish it, or any details and estimates of such a scheme, if such details and estimates exist, I will leave the discussion of that question to some one who is in possession of the necessary data.

In the broader field in which the company have embarked it has become necessary to interest out-

side capital. This has been done and the company has been completely reorganized. The name is no longer the Bear Valley Land & Water Co., as formerly, but is now the Bear Valley Irrigation Co., with a capital stock of $4,000,000. According to what is generally understood in regard to the company, it is their intention to at once construct the new reservoir and enter into the business of supplying water to irrigation districts on a large scale. This will be spoken of later under the head of Irrigation Districts.

The other property of the Bear Valley Irrigation Co. consists of the following ditches, canals, and pipe lines:

As has been stated in connection with the North Fork Canal, the Bear Valley Irrigation Co. owns one-half the capacity in that canal. This gives the company an outlet in a westerly direction for the waters of the Bear Valley Reservoir, by means of which they can conduct water on land north and west of the Santa Ana River. They have the right to enlarge the North Fork Canal in case they should desire to conduct more water northwesterly than the present canal is capable of carrying.

As already stated, there is a large portion of the famous Muscupiabe Rancho lying north and northwest of the city of San Bernardino which can be irrigated by an extension of the upper branch of the North Fork Canal. It is understood that the Bear Valley Irrigation Co. will conduct water on this tract as soon as the new dam is built, which will insure a sure and unfailing supply.

On the south side of the Santa Ana River the water from the Bear Valley reservoir is taken out at the mouth of the Santa Ana Cañon into the Bear Valley Canal, which has already been referred to in connection with the South Fork Ditch. After leaving the natural channel among the bolders of the Santa Ana Cañon the water let out of the reservoir is taken into a flume, which is the beginning of the Bear Valley Canal.

This flume is 48 ins. wide and 32 ins. deep and winds around the side of the southern bluff along the side of the Santa Ana River, a distance of 2,200 ft., until it lands the water upon the top of the mesa or bench land. Thence the canal is paved and cemented, crossing three deep arroyos by means of flumes until it reaches the bank of Mill Creek Wash.

The cemented canal is 2 ft. wide at the bottom, 5 ft. at the top and 3½ to 4 ft. deep. Its gradient is 8 ins. and 20 ins. to 100 ft. and its capacity is placed at 3,000 ins. under a 4-in. pressure (60 cu. ft. per second). Across Mill Creek Wash, the water is carried in a flume 48 ins. wide, 24 ins. deep and 240 ft. long. This flume is carried on a trestle which is a very poor and dilapidated concern. For the balance of the distance, something like 5 or 6 miles more, the canal is again constructed of rock and cemented. This action varies in size from 2½ to 3½ ft., 5 to 7 ft. on top and 2 to 4 ft. deep. Some portions are of smooth masonry and other portions are very rough, and the gradient varies much at different points. The route of the canal is first across the mesa to the foot hills of the southern range, and thence along the Southern Range to the Yucaipa distributing reservoir into which the canal empties its water.

To the west the waters are distributed in a 22-in. riveted wrought iron pipe for 1,225 ft., and thence along the upper edge of the mesa or on the steep hill sides is laid a 30-in. cement pipe 2,375 ft. long, with a grade of 0.3 ft. per 100. At this point is constructed a concrete chamber into which the waters are led and from which they are divided by means of weirs into four pipe lines.

One of these pipe lines crosses San Timoteo Creek to Mound City; another goes to Gladista and the Drew Tract; a third furnishes a portion of the Redlands colony, which does not get its water from the main canal or pipe; and the fourth supplies West Redlands or Terracina. These four pipe lines are each 12 or 13 ins. in diameter, and each has a distributing system consisting of many miles of smaller pipes.

[Since Mr. FINKLE wrote the above description of the Bear Valley Irrigation Co.'s works, several purchases of water rights and proposed improvements have been reported. ED. ENG. NEWS.]

THE SEMI-TROPIC SYSTEM.

This system, which supplies water for irrigation to 15,000 acres of land lying 4 miles west of the city of San Bernardino obtains its water from Lytle Creek and Artesian wells in the Lytle Creek Artesian Basin.

The waters of Lytle Creek, which rises in the Sierra Madre Mountains, northwest of the city of San Bernardino, are diverted at the mouth of Lytle Creek Cañon into a cemented canal by means of a boulder dam thrown across the stream. The elevation at the point of diversion is about 2,400 ft. above sea level, and the lower end of the canal is 1,400 ft. above sea level, giving the canal a fall of 1,000 ft. in about 6 miles.

The velocity of the water flowing down this canal is, therefore, very rapid, although there is not over 20 cu. ft of water per second being used through it at present.

The masonry of which the canal is constructed is excellent and substantial, the walls being 12 ins. thick, consisting of a double lining of boulders, the interstices between which are filled with hydraulic lime mortar. The surface is plastered to make it smooth with a coat of cement mortar composed of 1 part Portland cement to 3 parts of sand. Aside from the excellence of the masonry there is very little to be commended in the work. It shows an entire absence of intelligent engineering supervision in the following instances:

First. The size of the canal is much greater than was necessary to carry the flow of Lytle Creek, therefore making its cost more than double what it ought to have been.

Second. There is no weir or other provision for measuring the water at the head of the canal, therefore making it impossible to determine accurately the amount of water being taken into it.

Third. There is no provision made for taking water out of the canal at any point along the line.

Fig. 1. Horizontal Double Grinder.

Fourth. Angles are used where changes in the direction of the line occur, instead of curves. This would cause the water to break over the sides and wash away the banks of the canal if the canal should ever be required to carry one-half of its actua capacity, as the water would have a velocity of from 20 to 30 ft. per second, which would make it impossible for it to turn except on a gentle curve.

Fifth. There are no waste ways for storm water which will enter the canal during rain storms, and no provision made for collecting the storm water, and leading it across the canal.

From the end of the canal the water is distributed in parallel lines of cement pipes laid a quarter of a mile apart. These cement pipes are mostly 10 ins. in diameter, there being a few of the main ones which are as large as 20 in.

There is no provision made for measuring the water at any point where it is taken out of the distributing system, which is a grave defect, and will certainly cause trouble when the tract becomes more densely populated.

Besides the supply and works of the Semi-Tropical Land & Water Company from Lytle Creek, there is a supply from artesian wells. The wells are sunk on a tract of land in the Lytle Creek Artesian Basin, which lies a quarter of a mile north of the tract on which are situated the wells from which the new water-works of the city of San Bernardino derives its supply. There are about 20 artesian wells, ranging in diameter from 3 to 10 ins.; the total discharge of these wells is 6 cu. ft. per second. The water is collected from the wells into a flume 3 ft. wide by 2 ft. deep, in which it is carried about half a mile. Thence the water is carried in a 36-in. cement pipe a distance of about four miles. The capacity of the flume and pipe is three times the amount of water developed in the wells at present and the company expects to develop water enough in the future to fill its conduit.

The distribution system for this system is composed of cement pipes, the same as described in connection with the Lytle Creek System. The two systems supply water to the same tract, the Lytle Creek for the high portions and the Artesian for the lower portions.

The land which the present systems are capable of irrigating comprises 15,000 acres of choice citrus fruit lands lying west and northwest of the city of San Bernardino.

There are already several thousand acres planted to young orange and lemon orchards and much more improved to raisin grapes.

The principal town laid out on the tract is Rialto, which has several fine buildings and handsome residences already, and a population of 400 or 500 people.

THE CHINO PIPE LINE.

The Chino Pipe Line, which supplies water to the improved portion of the Chino Ranch, derives its water from artesian wells. The wells are developed near the foot hills, on the highest part of the ranch, and the water conveyed in the pipe line under pressure to supply the town of Chino and the adjoining acreage property.

The main pipe is a 10-in riveted sheet-iron pipe which has a total length of about five miles. The distributing pipe is also of iron, some being sheet iron and some lap-welded wrought iron. The water is delivered to the lands under about 50 lbs. pressure, and is taken out of the pipes by means of hydrants placed at suitable points. The supply of water from all the wells is about 10 cu. ft. per second.

This system is intended to supply the fruit lands on the Chino Ranch, comprising about 2,500 acres. The whole ranch consists of about 30,000 acres of land, which is mostly moist, and does not require irrigation when it is not used for fruit raising. The chief production of the Chino Ranch will be sugar beets, which can be raised without irrigation. There is now building a large beet sugar factory in the town of Chino, which will be completed in time to handle the crop of 1891 from about 5,000 acres. In succeeding years the crop will have to be increased, as the capacity of the plant will be sufficient to handle all that can be raised on the whole 30,000 acres. The land will be sold in tracts of from 10 to 40 acres to farmers who will raise the beets and sell them to the factory. The Chino Ranch is located in the southwestern portion of the San Bernardino Valley, south of Ontario, which has already been described.

The above completes the description of the principal irrigation systems in San Bernardino County, all of which have been constructed by private capital and enterprise, but which are now the property of the people who have purchased the lands which they supply. The people of each community have an organized company to handle their water, of which they themselves are the stockholders, and elect the directors and officers to manage the irrigation works. The cost of maintenance and distribution is paid by the owners in the proportion of their interest in the works by means of regular as-

sessments levied for that purpose. There are a large number of smaller irrigation works in the county, which are not of sufficient importance or interest to warrant a description here.

(To be continued.)

Centrifugal Grinding Machines.

For many years there has been no decided improvement in tool grinding machines adapted to every day use. Grindstones or emery wheels, used for tempered tools, must either be revolved at a very low rate of speed or water must be employed to keep the grinding surface from drawing the temper. Many ways have been devised for applying this water, but heretofore all have been open to some serious objection in service. The difficulty lies in the centrifugal force of the rapidly revolving wheel, which at anything more than a very moderate rate of speed throws off the water as fast as it drops upon the periphery of the wheel.

The centrifugal grinding machines, here illustrated, have been devised to remove these old difficulties, and they are radical in their departure from old-time practice. The new method applies the water to the stone or wheel at a point near its center; capillary attraction causes it to stick to the surface and accumulate in quantity until the centrifugal force drives it toward the circumference of the wheel. Outside of the wheel an encircling case catches all the water that flies off and leads it back to the tank. The faster the wheel revolves the faster the flow, and under ordinary rates of speed at least double the amount of water can be usefully applied that is possible with older machines. It will be noticed that the water flows over the surface of the stone with force, and at right angles, so to speak, to the direction of motion on the wheel. As a consequence the water is not so apt to fly off when in contact with the tool being ground, and the stone is kept clean and more effectually cools the tool at the point of grinding contact.

Fig. 2. Upright Grinder.

In the several machines here illustrated, Fig. 1 is adapted to machinists' tool grinding, and is provided with two grinding wheels, each 8 × 1¾ ins. The arbor connecting these wheels is made of steel, 1 in. in diameter, and runs in removable, self oiling bushings. The water is carried from the tank to the wheel by the force of a head and is brought back to the tank by centrifugal force. Fig. 2 machine carries a single horizontal wheel 12 ins. in diameter and 2 ins. thick, mounted on a steel arbor 1¼ ins. in diameter, running in removable bronze bushing. The grinding face is slightly beveled, so that long knives may be ground by laying them across the wheel. This machine is used for grinding all manner of wood working tools having straight edges. The water is brought on and distributed by centrifugal force only.

Fig. 3 shows a machine designed for grinding inside gouges, cutters and tools having concave cutting edges, and it will grind all such tools to a true arc of a circle, within its limits. It is supplied with water in the same manner as described for Fig. 1. This machine has been found especially useful for grinding molding and shaping machine cutters in car-shops and planing mills. All of these tools are made by Pedrick & Ayer, 1001, 1003 Hamilton St., Philadelphia, Pa., and they doubtless will answer any further inquiries.

Elevated Railway, Philadelphia, Pa.

The city of Philadelphia recently advertised for proposals for the construction and operation of an elevated railway on Market St., and the general specifications upon which the proposals were to be made were very full and complete. Bidders were required to file bonds for $500,000, and the successful bidder would have had to file bonds amounting to $2,075,000. No proposals were received, however, and the matter is again laid over. The following were some of the requirements of these general specifications:

The company to construct, maintain and operate a double track elevated railway in the middle of Market St. from the Delaware River to Juniper St.; on Juniper St. to South Penn Sq., to Broad St., to Market St., and then along the middle of Market St. to Sixty-third St. The company also to widen and strengthen the Market St. bridge over the Schuylkill River at its own expense.

The railway to be built upon iron or steel trestles, elevated upon abutments or piers, or other supports of iron, steel or stone, and to leave not less than 18 ft. clear headway between the under part of the trestle and curb line of streets. The columns which support the superstructure to be about 50 ft. apart longitudinally, and about 25 ft. c. to c. transversely. Metal catch-pans to be placed under the entire length of the structure. The gage not to exceed 4 ft. 8½ ins. All workmanship and material to be of the best quality, and the exterior finish neat and ornamental. The telegraph lines for the use of the railway to be attached to the structure, and the city to have the privilege of attaching its wires without cost or compensation. The stations to be not more than half a mile apart, and stations to be located at the Broad St. station of the Pennsylvania R. R., at the Reading Terminal R. R., on Market St., and at 23d and Market Sts. Cars not to be stored east of 43d St. The company to erect and maintain at its own expense one arc electric light under the structure at each street crossing. No bituminous coal to be used as fuel on the locomotives.

Cars to be run over the entire route, stopping at all stations, at intervals of not more than 10 minutes, except at intervals of 5 minutes between 6 and 9 A. M., and 4:30 and 7 P. M., and of half an hour between midnight and 5 A. M. The fare for a continuous ride to be 10 cts., except between 5 and 9 A. M. and 4 and 7:30 P. M., when it is to be 5 cts. After 2 years there is to be a uniform fare of 5 cts. The railway to be operated exclusively for passenger traffic, and no freight cars to be run under a penalty of $100 for each trip of each such car.

All plans for the construction of the railway, stations, buildings, signals, etc., to be approved by the Board of Public Works, and the construction to be subject to the supervision and approval of the Board.

Fig. 3. Gouge and Cutter Grinder.

All sewer, gas and water pipes, paving, etc., taken up to be restored to proper condition to the satisfaction of the Board. The railway company shall on the 10th of January, April, July and October of each year file with the City Controller a statement, sworn to by the President and Secretary, giving the number of passengers carried, the rate of fare for each passenger and the gross receipts of the railway during the preceding three months, and shall at the same time pay into the city treasury a sum equal to the accepted percentage of the gross receipts. The Controller to have the right to examine the books, papers and accounts. The railway company to file a bond for $50,000, to pay all damages caused to the city by the construction and operation of the railway, another bond for $25,000 to secure the quarterly payments and another bond for $2,000,000 for the payment of damages to property owners and tenants. The company to commence construction within six months and to have it completed within two years after the signing of the contract by the Mayor.

A WATER-WORKS TUNNEL FROM CINCINNATI TO LAKE ERIE having been proposed by some one as a means of relief from the doubtful Ohio River water, the problem has been examined by Mr. G. BOUSCAREN and another prominent civil engineer. The obstacles in the way are the lack of sufficient fall between Cincinnati and the lake, the distance and enormous cost, the latter being figured at $100,000,000 by Mr. BOUSCAREN'S associate. A more feasible plan would be to take the water from far up the river and pump it into settling basins of great capacity. According to the report of the State Board of Health, much sewage and surface drainage finds its way into the river near the present pumping station.

A NARROW-GAGE RAILWAY is under construction between Daullens and Albert, in the Department of Somme, France. A section of 19 miles was opened by the Minister of Public Works, on July 26, making the total length completed 168 miles, with 27 miles under construction. The total length of the line being 195 miles. The concession for the line, which has a gage of one meter, is owned by the Société Générale des Chemins de Fer Economiques, and the cost of construction is said to have been about $20,800 per mile.

Pipe-Tapping Under Pressure.

In our issue of Jan. 24, 1891, we showed a new device for tapping and connecting branches to water-mains, as devised by Mr. PHILIP ELEY, of 32 E. 25th St. Bayonne, N. J. Since that date the machine has been improved in some few essential features, and is now being officially tested by the water-works officials of Brooklyn.

To repeat, in part, our description of last January, this machine cuts out both caps and plugs in branches, and connects a branch pipe, with its valve, to a main, without letting out the water or reducing the pressure on the main. This is a sequence of operations never before attempted, we believe. The Brooklyn tests were very successful. The machine cut out a 6 in. hole in 1⅝ in. iron in 17 minutes.

The chief change in the plan, as now illustrated, is the substitution of the reciprocating lever arms for the former rotary motion produced by a crank. In practice it was found that the presence of smaller pipes sometimes interfered with the older operation. The spindle and the spindle shaft are hammered steel, and the friction collar is also of steel. This pipe cutter is regularly used at Bayonne and has given the fullest satisfaction. As previously remarked, it can be used to cut out the cap of a branch in a main, or a sleeve can be used and the piece be cut for the hydrant connection directly out of the main. The inventor, at the address given, will furnish any further information.

Public Improvements in Honduras.

The following notes are extracted from a consular report of Mr. J. J. PETERSON, U. S. Consul at Tegucigalpa:

Railways.—A concession has been granted by the government to a French company, at the head of which is Mr. GAUBERT, Honduras consul in Paris, to construct and operate a railway from Tegucigalpa, the capital of Honduras, to San Lorenzo, on the Bay of Fonseca, a distance of about 90 miles. The principal terms of the concession are that the company shall commence the survey of the road within 3 months from the date of the concession, commence the actual construction of the road within 6 months, and complete the road within 2 years from the date of the concession. The government guarantees to the company 6% per annum upon the capital actually and necessarily invested, said guarantee not to exceed 200,000 pesos per annum. The company is composed entirely of Frenchmen. It is confidently expected that this road will be built, which will give a much-needed outlet to the Pacific coast from this capital and from the mines and other interests on the Pacific slope. I am informed by the president, Mr. BOGRAN, that arrangements have been completed with the English company which owns the projected line of railway from Puerto Cortez to Amapala, called the Interoceanic line, to repair that portion already in operation from Puerto Cortez to San Pedro Sula, and to complete it as far as Portrerillas, some 30 miles further into the interior. This will make a distance of about 70 miles from the north coast (Puerto Cortez), which will constitute the first section. After the completion of this section, it is proposed to raise a loan for the completion of another section, and so on until the entire line is finished. Mr. BOGRAN informs me that the engineers are already on the line, and he is confident of the success of this great improvement, which has heretofore met with so many and so serious embarrassments.

Water-Works.—Another public improvement of importance is the building of water-works for the capital. The work is being done by the Government, and the contractors are W. H. Cole and George Gibson, two American citizens. The contract price is 160,000 pesos, which includes the erection of 6 public fountains in this city. The water is brought from a distance of 45,000 ft., and from an elevation of 5,000 ft. above sea level and 1,800 ft. above the city. The contract includes the laying of 65,000 ft. of mains and pipes. The source of the water is the River Jutiape, and there are 2 reservoirs of 225,000 galls. capacity each. The mains and piping vary from 12 to 6 ins. in diameter. It is purchased by the contractors in New York. The work is to be completed by July 1, 1891.

Wagon Ways.—Another matter of importance is the building of wagon roads. There is a road from La Brea, the port in the Bay of Fonseca on the south, through Tegucigalpa and Comayagua, and it is rapidly approaching Santa Barbara. The work will be pushed through as rapidly as possible to San Pedro Sula, when there will be a fair road across the entire country. There are a number of good bridges on this road already constructed and others in process of construction.

Trade with the United States.—The present need of Honduras is internal communication, and the pressing need of commercial relations between Honduras and the United States is the opening of these means of transportation through to the north coast. When wagon roads and railways give an outlet to Puerto Cortez, Truxillo and other portions of the north coast, an increase of trade with the United States may be expected to follow as a natural consequence. The income of this government does not justify the expenditure of large sums of money in public improvements, but those improvements are

The Eley Pipe-Cutting and Connecting Machine.

gradually coming under the progressive spirit which has for some years actuated the administration of its affairs.

THE MANCHESTER SHIP CANAL, now practically an accomplished fact, is 35 miles long, from the Mersey River to Manchester. There is a tidal division from Eastham to Runcorn, through the Mersey estuary, and from Runcorn to Warrington, 8 miles more. The bottom width of the canal is 100 ft., and the minimum depth, at low tide, is 26 ft. There are 12 locks in four groups of 3 each, with a total rise of 60 ft. The total excavation will amount to 50,000,000 cu. yds., and the total cost to $30,000,000.

THE CORINTH CANAL report for June last shows the removal for that month of 38,600 cu. metres. From the resumption of work in Oct., 1890, to the end of May, 1891, they had excavated 843,700 cu. metres. The total force employed is about 1,600 men. As will be remembered, the bulk of this work consists in flattening the slopes of the deep cut.

THE POWER PLANT AT THE WORLD'S FAIR, as now designed, will aggregate about 25,000 HP., including steam and electric motors. The great Corliss engine at the Centennial developed 1,456 HP., and at Paris in 1889, 6,000 HP. was required to drive the machinery. The machinery hall of the coming exhibition will have six lines of shafting each 800 ft. long. Each line is to be divided into four sections of 200 ft. each, each section to be driven by an engine; or in all 24 engines with a capacity of 125 to 200 HP. each. The combined pumping plant is expected to have a capacity of 40,000,000 galls. daily. The electric plant is figured at 16,000 HP.

A "WALKING-BEAM" TOWER for the World's Fair is proposed by Mr. OBERLIN SMITH, of Bridgeton, N. J., and President of the Am. Soc. M. E. The design includes a 600-ft. tower "of severely plain contour," surmounted by a sheet metal statue of Columbus, about 125 ft. high. The top of the tower would be dome-shaped and 100 ft. in diameter. Pivoted to the top of this tower would be a huge oscillating beam, 1,100 ft. long, 150 ft. wide at the center and terminating in two globes 100 ft. in diameter. These globes would have floors and proper windows and be so pivoted as to keep the floors horizontal during the ascent and descent. The beam would be made to oscillate by hydraulic cylinders with proper gearing. The report credits Mr. SMITH with proposing to make the ascent of 1,100 ft. in "3 or 4 seconds,"—rather rapid transit. But while the whole outfit would be utterly lacking in beauty there seems to be no doubt that it could be made an excellent money-making machine. Nothing is said about providing for wind pressures. But assuming that the design was a feasible one the advantages could be summed up about as follows: A very rapid trip to a great height, the filling of one globe while the other was at the top, and the effectual stop put to "loafing" in the air, as when the ball comes down the tourist must come with it. The result would be a rapid sequence of paying loads and no crowding. Sufficient money and mechanical skill would doubtless make it safe, and the appliances for working the beam would be very simple as compared with an elevator outfit of equal capacity.

AN EIFFEL TOWER, superior to the one in Paris, is proposed by M. EIFFEL himself in a communication to the World's Fair directors in Chicago. The fuller details are to follow by invitation of the directory.

A CHICAGO UNDERGROUND RAILWAY COMPANY was incorporated lately with a capital of $10,000,000 in stock. The purpose of the corporation is declared to be the construction of a tunnel from the north line of the Chicago River, at Cass St., south under the center line of Wabash Ave. to Eighty-first St. There is said to be abundant capital back of the project, and it will need it, as the engineering difficulties will be great. Its eventual use would be as a line leading general railway traffic to a central terminal, common to all roads. As showing what may be encountered in construction, it is said that the new 6-ft. water-works tunnel, located 60 to 70 ft. underground, has caused serious cracks in the ordinary buildings along the line. The old 8-ft. tunnel, 80 ft. underground, however, caused no special trouble of this nature.

THE HIGH SERVICE BRICK SUPPLY AQUEDUCT OF VIENNA, which is nearly 55 miles long, and is carried in many places by series of stone or brick arches, gave considerable trouble formerly by becoming "wet" on the soffit of the arches and sides of the walls. On carefully investigating the matter it was found that the difference in temperature between the inside and outside of the aqueduct caused extremely small cracks to occur in the Portland cement lining, through which the water slowly escaped. For some years it was customary to replace the worst portions of the lining every fall, the local conditions preventing any extensive repairs taking place simultaneously. According to the *Wochenschrift des oesterr Ingenieur-Vereines*, a preparation is now used which can be laid over the cement and is elastic enough to stretch without showing cracks. This preparation was invented by Herr JOHANN BOSCH, who has called it "boschin." Its principal ingredients are said to be asphalt, india rubber and mineral tar, and it costs about 2½ florins per sq. m., or about 95 cts. per sq. yd. The material has been subjected to very exhaustive tests of its adhesion to cement, its impermeability and harmless character with regard to the water supply, and is reported to have proved satisfactory in every respect.

THE BROOKLYN SEWER, now being built by Hart, Anderson & Barr, is 12 ft. and 15 ft. in inside diameter, with 16 in. brick walls and 9,400 ft. long. It extends from Greene and Marcy Aves., through Green Ave., Hanson Place and Fourth Ave. to Dean St. From Dean St. and Fourth Ave. to Gowanus Canal there is 3,000 ft. more of sewer, built in the ordinary way. The 3,000 ft. of open cut is practically finished and 4,500 ft. of the tunnel part is done. The tunnel portion is from 35 to 80 ft. below the street surface. The tunnel is mainly through fine sand and gravel, and the "pilot tube" invented by Mr. JOHN ANDERSON, and already described in this journal, is used.

THE STREET CLEANING OF NEW YORK for 1892 will cost $2,653,233, according to Commissioner BEATTIE'S estimate. This is an advance of more than a million dollars on the appropriation of 1891, which was $1,584,250. The working plant proposed includes 1,700 patrolmen, 600 carts and drivers, and 88 hostlers. This force will cost $1,494,888. Salaries foot up to $38,400; supervision, $162,600; carts, vans, horses, harness, etc., $309,120; disposition of material, $275,000; horse shoeing and feeding (650 horses), $118 625; temporary labor in removing snow and ice, $100,000; rent of offices and 11 stables, $60,000; repairs and renewals of plant, $40,000; contingencies, $20,000, and police, $73,000. In the final disposal of street refuse by contract, Mr. BEATTIE estimates the value to the contractor of the "scow trimmings" at $5,460 per month. Much of the increase in the present estimate is due to the increased pay of $2.00 per day for patrolmen, cart drivers, ostlers, etc.

Utilization of Sewage.

The *Contract Journal* of London, England, states that the Board of Houghton-le-Spring has decided to adopt a system of sewage utilization recommended by Mr. D. BALFOUR, M. Inst. C. E.

The process consists in first mixing the sewage in large tanks (in duplicate) with alumino-ferric, a cheap chemical which contains 46.7% of sulphate of alumina, which is suspended in iron baskets or cages immersed in the sewage to admit of the necessary proportion being dissolved to effect precipitation. It does not, like a large number of chemicals, require any machinery, or add any bulk to the sludge, being entirely soluble in water. It exercises a deodorizing effect, and is not liable, being a neutral salt, to refermentation. The clarified sewage is then passed onto 10 acres of loam land laid out for intermittent filtration, which consists in forming the land into half-acre beds, broad ridged and furrowed, and used in regular rotation, and having special under drainage with ventilation shafts, from which, with regular and systematic management, the effluent will pass in a colorless and inodorous state. As sufficient suitable land could not be obtained, this chemical precipitation process was conjoined with the available limited land for the purpose of chemically precipitating and deodorizing the solid matter as much as possible before applying the sewage to the land. Various succulent crops, including vegetables and osiers, are grown on the ridges, the sewage filling the furrows. The scheme was approved by the Local Government Board, and the contract for carrying it out has been let by the Local Board of Health to Mr. JOHN CARRICK, contractor, Durham, under the superintendence of the engineer.

The Eiffel Tower Pressure Gage.

The pressure gage, constructed at the Eiffel Tower, in Paris, by Messrs. CAILLET and G. EIFFEL, is 984.3 ft. in height. Pressure gages open to the atmosphere are the only gages upon which the pressure of gases and liquids can be accurately measured, and the only other one comparing with this was that at an artesian well at the Butte-aux-Cailles, which was 328 ft. high. On the gage at the Eiffel Tower the pressure of 400 atmospheres can be measured. As this is too great for a glass tube, a tube of mild steel 0.157 in. internal diameter is employed. This is joined at the bottom to a mercury chamber.

Owing to the form of the tower a vertical tube was impossible, and, as the height of the mercury cannot be seen in the steel tube, cocks are put in at intervals of 10 ft., communicating with glass tubes and showing the reading upon varnished wood scales alongside. In order to obtain a given pressure a hydraulic pump is worked slowly. A telephone is used for communicating with the pumproom from any platform. As the scales on the pipe are not in a straight line, owing to the inclination and form of the tower, the levels of certain points are obtained with great accuracy and used as a datum in comparing the scales. A large metal pressure gage is placed near the hydraulic pump, and this is graduated so as to indicate the atmospheres, and also the precise cock above which the mercury has risen. As it is necessary to know the temperature of the column of mercury at each test, this is measured by the variations in the resistance of the telephone wire, which runs close to it. It should be said that the tube is accessible at intervals 10 ft. apart, and this is the feature especially lacking in all experiments in wells, etc. It was erected for purely scientific purposes, and many experiments are now being made by French scientists.

Water-Works of Pretoria, South Africa.

The new water-works of the city of Pretoria, in South Africa, are described as follows in a recent issue of *Industries*, London, England:

The new Pretoria water-works were recently opened by the President of the Transvaal Republic. They were designed by Pritchard & Co., Civil Engineers, of London, after a personal examination of the district by Mr. E. Pritchard, M. I. C. E. The water is obtained from a place known as "The Fountains," a title given to an extraordinary spring of beautiful water, of which there is available 5,000,000 to 6,000,000 galls. per day, rising out of the rocks at an elevation of about 5,000 ft. to 6,000 ft. above sea level, and nearly 200 ft. above the level of the city of Pretoria. The supply is by gravitation, and the whole of the large-size water mains are of thin rolled steel with lap-welded joints. There are some 50 miles of mains and pipes from 18 ins. diameter and under, the excessive cost of transport by bullock wagon rendering absolutely necessary the substitution of wrought-steel tubes for cast-iron pipes. The works are designed for the ultimate supply of 40,000 people, and have so far cost approximately $500,000. The annual cost of supply will be a minimum one, consequent upon the natural facilities offered in the construction of the works, and the great purity of the water discharged from the rocks at "The Fountains" both in winter and summer, unvarying in quality, always bright and sparkling. The Pretoria Water-Works Co. is entitled to charge a maximum price of $2.50 per 1 000 galls., this being the sum charged a short time since in some of the South African cities. The lap-welded steel mains were manufactured by James Russell & Sons, of Wednesbury, England, and the service pipes by E. Smith, of Wednesbury. The valves and fire appliances were supplied by the Glenfield Co., Kilmarnock, and the brass fittings by C. Winn & Co., of Birmingham.

Testing Steel Tires.

Steel tires, says the *Revue Générale des Chemins de Fer*, Jan., 1891, are subjected to three kinds of stress for testing the quality of the metal: Tensile resistance of samples cut from tires, flattening tires by hydraulic pressure to the extent of one-sixth or one-seventh of the interior diameter, and submitting sample tires to shocks of a falling body. The first and second, though useful, are incomplete, whereas the trial by shock proves that the tire is capable of active resistance; and, in specifying given conditions of deformation, the resisting qualities of the metal are well brought into evidence. Besides that, the shock proof reveals defects which are not proved in the ordinary trials by tension or by compression. The metal may be rendered brittle by the presence of certain metalloids, though perfectly resisting statical stress.

To ascertain the quality of the material of which tires are manufactured, shock trials must be in relation to the dimensions of the tires. To obtain steel of suitable hardness, the maximum deformation produced by the shock of the fall must be prescribed, also a minimum percentage of carbon. The shock is applied to the tire on edge, diametrically.

It is deduced from the tabulated results of shock trials that the work done on the tire diametrically compressed is independent of the diameter for a given relative deformation, which is taken as one-sixth of the diameter. Again, the work done is proportional to the modulus of flexure of the cross-section. For tires of identical section but of different diameters the same relative deformation corresponds to the same fall of the ram; and, for tires of different sections, shocks proportional to the moduli of flexure cause the same deformations relatively to the diameters.

From the results of this experimental investigation the following tests have been established on the Belgian state railways in contracts for tires: Minimum proportion of carbon, 0.30%. Shock trials, first, for tires of locomotives and tenders, 3 blows of the ram of 6,600 kilogram-metres (47,738 ft.-lbs.); second, for tires of carriages and wagons, 3 blows of the ram of 4,000 kilogram-metres (28,932 ft.-lbs). After the second blow, the reduction of the interior vertical diameter is not to exceed one-seventh of the normal diameter; but this stipulation does not apply to wagon tires. It is preferred that the test tires should be selected from the same running. A maximum of 0.08% of silicon may be imposed.—*Abstracts of Papers, Inst. C. E.*

Screw Piles.

The following note is an abstract from an interesting book, recently published, entitled "Scamping Tricks:"

Piles can be screwed with a small pitch when sufficient power can be obtained to make a steep pitched screw penetrate. Piles with a single turn of the screw, it seems to me, are the best, although the double-threaded screw may be right in soft marshy ground; but the usefulness of a double-thread is doubtful, for I believe it breaks up the ground for no good, although some state that the screw threads work in parallel lines, and that a double-threaded screw is steadier, for they say a single-threaded pile is always likely to turn on the outside edge of the blade, and that the double-threaded is not, as it has a lip on both sides.

Legal Decisions of Interest to Engineers.

Liability of City for Change of Street Grade.—Under the constitution of the State of Nebraska, a city which raises the grade of the street is liable in damages to the owner of abutting property who has constructed buildings thereon, although at the time the buildings were constructed there had been no grade established, and he might have seen from the circumstances that when one was established it would be higher than the material grades. (Hammond v. City of Harvard, Sup. Crt. of Nebraska, 48 N. W. Rep. 462.)

Damages for Operation of Road.—The right to sue a railway company for damages caused to adjacent property by the operation of the road accrues as soon as the road is used for transporting freight and passengers. Where a railway track is laid in the middle of a street so as to leave 19 ft. on each side of it between the track and the sidewalk, the owners of lots facing on the street have no right of action for interference with access to their property. A railway company whose track runs through a city street is liable to the owners of adjoining property for damage thereto caused by the soot, smoke and discomfort caused by running its trains. (L. & N. Ry. Co. v. Orr, Ct. of App. Ky., 15 S. W. Rep., 8.)

Compensation for Trespass Prior to Condemnation of Land.—Where a railroad company enters upon and appropriates land for a right of way without consent of the owner or by proper legal proceedings, it becomes a trespass, and will not be relieved of liability therefor by subsequent proceedings to secure a right of way; and, in considering what is due compensation for the easement so acquired subsequent to the trespass, the trespass itself is not involved nor to be considered. (Canton, A. & N. Ry. Co. v. French (Sup. Crt. of Miss., 6 So. Rep.), 512.)

Liability of City for Defective Bridge.—The fact that a municipal corporation has no funds with which to repair a defective bridge which is a part of its highways is no defense to an action for the recovery of damages sustained by reason of its defective condition. And when a judgment of this nature has been recovered, a taxpayer cannot come in and sustain collection of the judgment jurisdiction on the ground that the village had a valid defense to the action, which was not presented, unless it can be shown that such defense was withheld by collusion with the property. (Carney v. Village of Marseilles (Sup. Crt. of Ill.), 26 N. E. Rep. 491.)

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Toledo, Walhonding Valley & Ohio.—About 60 bids were received for grading this line from Coshocton to Loudonville, O. The contract has not been awarded yet. Bids for the rails, cross-ties and bridge timber will be received in about two weeks. Chief Engineer, John A. Hanlon, Canton, O.

West Virginia Central & Pittsburg.—The survey for the proposed line from Cumberland to Hagerstown, Md., 78.4 miles, has been completed. The engineers' report will be submitted to the directors at once, and it is expected that a meeting will soon be called to consider the question of construction.

Lehigh Valley.—Work has begun on the proposed branch from Berwick to White-Haven, Pa., 12 miles. The work will cost about $300,000.

Beech Creek.—The statement that the contract had been let to Mr. Miller, of Lock Haven, Pa., for building an extension into Cambria County, as noticed in our last issue, is incorrect. The contractors are Geo. S. Good & Co., of Lock Haven, who are ready to sublet the work.

Lake Shore & Michigan Southern.—At a recent meeting of the directors of the Toledo & Ohio Northern R. R. it was decided to begin the construction of the line from Fayette, O., to Shipshewana, Ind., at once.

Central R. R. of New Jersey.—The right of way has been secured for a branch to Long Branch, N. J., along the base of the Atlantic Highlands. The present terminus at Sandy Hook will be abandoned.

Chest Creek.—A press dispatch states that the contract has been let to Charles McFadden for building 17 miles more of this line. Work is already in progress on 3 miles of the line. The work will include a large tunnel near Carrollton, Pa. John Patton, Curwinsville, Pa., President.

Philadelphia & Reading.—This company will build a 1¼-mile branch from Tower City to Brookside, Pa.

Delaware, Lackawanna & Western.—This company has secured control of the Syracuse & Baldwinsville R. R., running from Baldwinsville to Amboy, N. Y., 8 miles, and will improve the line and build a 1¼-mile connecting line at Syracuse, N. Y.

Lancaster, Oxford & Southern.—It is announced that this line from Oxford, Pa., to Singerly, Md., will not be put under construction until this fall. A 3-mile branch from Singerly Station to Singerly's Mills, Md., will be built at once.

Baltimore & Ohio.—The Akron & Chicago Junction R. R. has now been opened for both freight and passenger service. The line runs from Akron, O., via Warwick, to Chicago Junction, 73 miles, and is built in a very substantial manner. Work was begun in August, 1890, by the contractors, Ryan & McDonald, of Baltimore, Md., and the line was completed and opened for freight traffic in July, 1891. This line, together with the Pittsburgh & Western R. R., will furnish the B. & O. a new line to Chicago about 62 miles shorter than its present line, and with much easier grades.

Canadian Pacific.—Work has been begun on large coal docks at Fort William, Ont., to have a capacity of 160,000 tons. New grain elevators will also be built and other improvements made at this place.

Cumberland Valley.—A press dispatch says:

A party of surveyors, said to be in the interest of the Cumberland Valley R. R., has been making a tour through Cumberland, York and Adams counties, surveying a new line to Gettysburg in opposition to the Philadelphia & Reading's new lines. It will connect with the Cumberland Valley near White Hill, 2 miles west of Harrisburg. It will take in Lewisberry, Manchester and other points not at present touched by any other railroad, and will be a more direct route to the battlefield.

Pennsylvania.—Construction is in progress upon the proposed branch from Bridgeport, Pa., on the Trenton Cut-off, to Swedeland Furnace, 1½ miles.—The Turtle Creek Valley R. R. is nearly completed between Stewarts and Murrysville, Pa., 7 miles, and it is probable that work will soon begin on a further extension to Belmont.—Ten miles of the South Fork Branch from South Fork Station, on the main line, up the South Fork Creek, have been completed and opened for business. Surveys are now in

progress for a further extension to Bradford, Pa., about 45 miles. The route is through a fine timber region.—The Trenton Cut-off is now completed from Glen Loch, Pa., to Morrisville, N. J., a distance of 52 miles. The object of the line is to furnish an independent route with low grades and curves for the through freight from the West to New York and thus avoid the terminal delays at Philadelphia and the heavy grades and curves of the more southern line. Only one track has been laid thus far, with 3,000 ft. sidings every two miles, but the roadbed has been constructed for two tracks and an additional track will be laid when needed. The maximum curve is between one and two degrees and the maximum grade 30 ft. per mile. All highway crossings are either above or below the tracks. The ties are laid on a stone sub-ballast 12 in. deep and an additional 6 in. of stone is then put on, making the ballast flush with the tops of the ties. The rails weigh 85 lbs. per yard. About 11 miles will be saved in the shipment of through freight to New York.

Projects and Surveys.

Laurel & Roaring Point.—At a recent meeting of the stockholders the following officers were elected: President, A. J. Horsey; Vice-President, W. T. Records; Treasurer, T. C. Horsey, and Secretary, A. F. Jones. Ten thousand dollars have been deposited as a security for the $50,000 State loan. Work, it is stated, will begin next month. The road is projected to run from Laurel, Del., to Tyaskin, Md., 25 miles.

Springfield.—A correspondent writes us that the surveys have been finished for this proposed railway from Cavendish Station, on the Central Vermont R. R., to Springfield, Vt., 13 miles. Geo. A. Ayre, of Perkinsville, Vt., is the Chief Engineer.

Weygadt Mountain.—Chartered in Pennsylvania to build a railway from Easton to a pleasure resort in the vicinity.

SOUTHERN.—Existing Roads.

Ohio Valley.—The city of Hopkinsville, Ky., has voted $115,000 in aid of the proposed extension from Princeton to that place. It also guarantees the right of way and land for terminal facilities.

Chesapeake & Ohio.—It is stated that the Craig Mineral R. R. will build branches from New Castle, Va., up Craig's and John creeks.

Middle Georgia & Atlantic.—Location has been begun between Savannah and Eatonton, Ga. Contracts for construction will be let soon, and the company is ready to buy rails and rolling stock. Chief Engineer, Arthur Pew, Savannah.

Nashville & Knoxville.—The contract for building the extension of this Tennessee railway has been let to the C. C. King Construction Co. The distance is 7 miles. Contracts for 10 miles more will be let in September.

Archer & Dunnellon.—The contract for tracklaying has been let to Joseph Hawthorn.

Wilmington, Onslow & East Carolina.—About 300 men are now at work, and 18 miles of the right of way from Jacksonville toward Newbern, N. C., have been cleared.

Macon & Atlantic.—The grading force is being constantly increased, and good progress is being made. Tracklaying will soon be resumed.

South Bound.—In a recent interview an official of this road says:

The road is completed from Savannah or the junction with the Central R. R. of Georgia, 4 miles from Savannah, to the junction with the South Carolina R. R. at Graham, a distance of 91 miles. The remaining distance to Columbia, 51 miles, remains to be completed. The grading upon this portion of the line is about completed, and track is being laid at the rate of 1½ miles per day. The whole line will be completed by October, and we expect to run trains from Savannah to Columbia by Oct. 12. All the line between Savannah and Graham on the South Carolina R. R. is completed, except the Savannah River trestle, which will be completed by Aug. 15. We contemplate putting on a schedule train Sept. 1 between Savannah and the South Carolina junction. The track is well laid, the roadbed is in good condition and a 45-miles-an-hour schedule can be made on it.

Paducah, Tennessee & Alabama.—N. R. Olcott, of Paris, Tenn., Chief Engineer, writes us as follows:

The surveys have been completed for the extension from Paris to Hollow Rock, Tenn., and construction began Aug. 6. About 100 teams are now at work, and it is expected to begin tracklaying about Oct. 1, and to have the line completed by Dec. 1. The work is medium; maximum grade 0.01% and maximum curve 6°. The road traverses a rolling country, and its principal business will be in cotton, tobacco and lumber. The contractors are: Brown Bros., L. J. Moss, St. Louis, Mo.; C. O. Faught & Co., St. Elmo, Ill., and M. S. Curtler & Co., of St. Louis, Mo. The work is in charge of the Chief Engineer.

Projects and Surveys.

Atlanta & Gulf.—Chartered in Florida to build a railway from a point on the Atlantic coast, in St. Johns Co. to the Gulf of Mexico, 128 miles. James Shears, of Charlotte, N. C., is interested.

Dover & South Bound.—The Goldsborough Lumber Co. will build a standard gage logging railway from Dover, N. C., north, 7 miles and south, 10 miles.

Point Pleasant & Atlanta.—This road is projected to run from Point Pleasant, W. Va., to the mouth of Coal River, 45 miles. T. L. Brown, of Charleston, W. Va., is interested.

Silver Springs & Western.—Chartered in Florida to build a railway from Silver Springs to Ocala and Dunnellon, with a branch to Archer, 60 miles. The directors are: F. A. Teague, R. L. Anderson, and H. L. Anderson.

Georgia.—The following bills have been introduced into the Georgia State Legislature: to incorporate the Toque & Tallulah River R. R. Co., H. L. Culberson, Atlanta, the Hawkinsville R. R. Co., and a company to build a railway from Atlanta to Manchester, W. R. Hammond, Atlanta. Bills to charter the following companies have become laws: Dalton & Spring Place R. R. Co., Dalton, Ga., to Tate, Ga., C. C. Davis, H. C. Hamilton; Cumberland Short Line R. R. Co., W. B. Borroughs, John A. Foster; Brunswick, St. Mary's & Florida R. R. Co., incorporators same as for Cumberland Short Line R. R. Co.

Knoxville, Montville & Chilhowee.—This company has applied for a charter to build a railway from Marysville to Montville, Tenn. Among the incorporators are: L. T. Hamilton, L. D. Dillon, and J. Luttrell Murphy.

Greenbrier & Gauley.—Alex. McVeigh Miller, of Alderson, W. Va., President, writes as follows:

This railway is projected to run from Alderson, W. Va., on the Chesapeake & Ohio R. R., via Blue Sulphur Springs, Meadow Bluff and Ruperts to Gauley, a distance of 45 miles. Twenty-five miles of the preliminary survey have been run and 7 miles are located. The work will be light with the exception of 10 or 15 miles through the mountains. The object of the road is to develop the coal and timber lands. About $38 000 has been secured in aid of the enterprise and further help has been promised. The company was chartered in March, 1891. Wm. Proctor Smith is Chief Engineer.

Madison & Eatonton.—J. H. Holland, of Madison, Ga., writes us that the surveys have been completed for this railway from Madison to Eatonton, Ga., 22 miles, and that the right of way has all been secured.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—Track has now been laid to a point about 20 miles northwest from Grand Rapids, Minn., completing the line as far as graded last year. An election will soon be held in Polk Co. to vote upon the matter of appropriating $22,000 in aid of the line on condition that it runs to Crookston, Minn., instead of to Winnipeg, Man.

Canada.—A bill has been introduced into the Dominion Parliament providing for a subsidy of 6,400 acres of land per mile for the following railways: Southwestern Colonization, 62 miles; Manitoba Southwestern Colonization, 6¼ miles; Canadian Pacific, Souris Branch, 60 miles. All these lines are extensions of the Canadian Pacific Ry. in Manitoba and Assiniboia.

SOUTHWEST.—Existing Roads.

Hope & Lewisville.—John A. Roberts, of New Lewisville, Ark., President, writes us as follows:

This road is projected to run from a point on the St. Louis Southwestern Ry., about 1¼ m les west of Louisville Station, north to Hope, Ark., a distance of 24 miles. Three miles have been completed and are in operation, and construction is in progress upon an additional two miles. The route is through a farming and timber country and the principal business of the road will be in farm produce and lumber. The company was chartered in November, 1890. M. D. Tilson, of Texarkana, Tex., is Chief Engineer.

Projects and Surveys.

Beeville, Legarto & Rio Grande.—H. Stedman, of Lequito, Tex., writes as follows:

Subscriptions amounting to about $75,000 were received in aid of this enterprise, but nothing further has been done. The road is projected to run through a good agricultural and stock-raising country, affording light work.

Rusk, New Birmingham & Dallas.—E. C. Dickinson, Rusk, Tex., President, writes as follows:

This road is projected to run from Rusk, Tex., to either Reynolds, Troupe or Palestine, as may be decided upon. The work will be light. T. Howard, of Barnes, Tex., is Chief Engineer.

St Louis, Collinsville & Carondelet.—M. M. Powell, of Collinsville, Ill., Secretary, writes us as follows:

This road is projected to run from Madison, Ill., opposite St. Louis, Mo., via Collinsville, O'Fallon and Belleville, Ill., to East Carondelet, Ill., with a branch to Lebanon, a total distance of 50 miles. The preliminary survey has been finished. There will be one bridge and about 3,000 ft. of trestle. The earthwork will average about 25,000 cu. yds. per mile; maximum grade, 1%, and maximum curve 5°. The right of way has all been secured. The road is independent, and is being built to develop coal fields and interchange of traffic between railways entering St. Louis. Negotiations are now under way for constructing the line. The company was chartered in Oct., 1890. A. M. Powell is President and S. A. Mitchell is Chief Engineer.

Omaha, Kansas Central & Galveston.—A press dispatch from Denison, Tex., Aug. 5, says:

Mr. Pool, advance representative of Mr. Robinson, contractor of the Omaha, Kansas Central & Galveston Ry. from Denison to the gulf, has arrived here with his family and states that his brother will be here with a very large construction outfit in 10 days when they will be at once strung out along the line from Denison south. The first hundred miles of the line is to be ready for rolling stock by Jan. 1. The bridge timber has already been bought in Oregon and will be of Oregon fir. Contractor Butler already has several large gangs of men at work on the line between Omaha and this State, and is pushing everything in his power toward an early completion. The line will be an air line from Omaha to a deep-water port on the gulf and will be the great outlet for the grains of Nebraska, the cereals of Kansas and the mineral, cotton and lumber of Texas. It is backed by a large English syndicate and ample money for the completion of the road is already secured. The line of the Union Pacific survey made and abandoned ten years ago is being followed. Vice President Rawbus and Chief Engineer Roemer will arrive here from New York in a few days.

Velasco Terminal.—Chartered in Texas to build a railway from Velasco, Tex., through Brasoria Co., to Arcola Junction, 40 miles. Among the incorporators are: E. J. Wilson, Frank Caldwell and E. L. Dryer, all of Velasco.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—About 55 miles of track have been laid on the Seattle & Montana R. R. from Seattle north, and work is now progressing at the rate of 1 mile per day. Work is also in progress from Jarman south, and several miles of track have been laid.

San Joaquin Valley.—The right of way has all been secured, and grading is now in progress on this road. The contractors are Fitzgerald Bros., of Oakland, who have the grading of the first 23 miles from Fresno. The route from the town is in a northwesterly direction, crossing the San Joaquin River at Hamptonville, and then straight into the Sierras. The survey has only been run for a distance of 50 miles, but a corps of engineers are at work, and will probably complete this portion of the job within the next two or three weeks. North of Hamptonville the survey runs back to the river from 6 to 10 miles, thence nearing the river again about 30 miles from Fresno. The section now under contract is easy earthwork on the plains, but a few miles beyond the proposed line runs through a chain of hills, and still farther on there are about 25 or 30 miles of heavy mountain work, near the northern part of the survey. From the main line it is proposed to construct several branches also for timber traffic, aggregating about 35 miles. A bridge across the San Joaquin River will be an important work, and there are several smaller ones to be constructed before the proposed timber route can be completed. The company has elected the following officers: President, Marcus Pollasky, San Francisco; Vice-President, Thomas Hughes, Fresno; Secretary, Gilbert Osmun, Fresno; Treasurer, J. C. Quinn, San Francisco, and Chief Engineer, O. T. Barron, of Fresno.

Projects and Surveys.

Snake River, National Park & Pacific.—Organized in Idaho to build a railway from Idaho Falls, Idaho, to the Snake River coal fields in Wyoming, with a branch to the south end of Jackson's Lake, Wyo., a total distance of 160 miles. The principal offices will be at Idaho City. President, J. C. Anderson; Vice-President, B. McCaffrey, and Secretary and Treasurer, A. V. Scott.

FOREIGN.

Lower California.—An official of this road is quoted as saying that the line would be completed in 18 months. It is projected to run from San Diego, Cal., south to San Quentin in Lower California, 150 miles, and from San Diego to Yuma, Arizona. The portion from San Diego south will be constructed first. All surveys have been completed and grading is in progress. The work is comparatively light; maximum grade 105 ft. per mile and maximum curve 9° 30'. There will be several important bridges. Sufficient rails are on hand to complete 20 miles of road. The company will receive aid from the Mexican government.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable at the following places: Los Angeles, Cal., address Capt. John Cross; Alexandria, Va.; West Superior, Wis., address H. V. B. Smith; Macon, Ga., address the Metropolitan Street Ry. Co.; Stockton, Cal., address J. H. Henry, of Sacramento; San Jose, Cal., address J. Rich, Nantucket, Mass.; Streater, Ill.; Spearfish, S. D.; Olean, N. Y.; Honeoye Falls, N. Y.; Waterville, Me.

Wilmerding, Pa.—The Braddock & Turtle Creek Ry. Co. has opened books to increase its capital stock from $100,000 to $130,000, the money so obtained to be used in building an extension to this place and to Keating Station.

Altoona, Pa.—T. C. Wiley, of Lancaster, will build a line between this place and Hollidaysburg, a distance of 7 miles.

Florence, Ala.—Surveys for the Florence Electric Street R. R. have begun. The road is to be about 3 miles long.

Montgomery, Ala.—The Montgomery Terminal & Street Ry. Co. has decided to put in an electric plant costing about $80,000. Work will begin as soon as the necessary franchises are obtained.

Covington, Ky.—A survey is under way to determine the route of the Rosedale, Cincinnati & Covington line. Two routes are possible, by each of which the cost of the road will be about $150,000.

Cleveland, O.—The Woodland Ave. & Westside Street Ry. Co. had deciden to equip its lines with electricity and will put in an overhead system. It is the last large line in the city to give up horses.

Kankakee, Ill.—The Enterprise Electric Light & Railway Co., capital stock $100,000, will apply soon for a franchise to build a road to North Kankakee and Bourbonnais Grove.

Bloomington, Ill.—According to the *Electrical World* work upon a second system of electric railway in this city and Normal will probably begin at once. A representative of the Thomson-Houston Electric Co. is now in Bloomington, and steps are being taken to form a stock company to construct 10 miles of line and equip it with 15 cars.

Minneapolis, Minn.—A line to Robbinsdale and St. Louis is under discussion.

San Antonio, Tex.—The San Antonio Rapid Transit R. R. Co. is at work on its power-house and will soon be ready to install an electric plant.

Horse Railways.—*Bedeville, Ala.*—Col. T. L. Bulger has filed articles of incorporation for a company to build a line here. He expects to have the work done in two months.

Kingsland, Ark.—The iron road from Kingsland south to the Ouachita River will probably be built by S. A. Graves, W. H. Starr, H. C. Draham, C. M. Danes.

Cable Railways.—*Philadelphia, Pa.*—It is reported that the Hestonville, Mantua & Fairmount Passenger Ry. Co. will put a cable on a part of their lines.

Baltimore, Md.—Engineer Connett of the City Passenger Ry. has completed a survey of the White line and will now begin on the Red line. He is now receiving bids for the track and slot rails.

Chicago, Ill.—The West Chicago Street R. R. Co. will cable Fulton St.

San Francisco, Cal.—The Supervisors have granted the petition of the Omnibus Cable Co. to lay tracks on several streets.

New Companies.—The Elevated Singletrack Cable Construction Co., Chicago, Ill.; capital stock, $500,000; incorporators, G. W. Cole, P. Amick, J. E. Marder. Sodaville Ry. Co., Sodaville, Ore.; incorporators, Dr. J. L. Hill, W. W. Parrish, H. J. McCartney and others; object, construction of a dummy line from Sodaville to Albany. Citizens Passenger Ry. Co., Mt. Pleasant, Pa.; capital stock, $50,000. Buffalo & Williamsville Electric Ry. Co., Williamsville, N. Y.; capital stock, $50,000; incorporators, H. Taylor, J. Satterfield, R. F. Parsons and others, of Buffalo. Weygadt Mt. Ry. Co., Easton, Pa.; capital stock, $30,000; President, J. M. Young. Chilliwack Tramway Co.; Chilliwack, B. C.; capital stock, $25,000. Jameson Street R. R. Co., Sterling, Ill.; capital stock, $50,000. City Railway Co., Fort Worth, Tex.; capital stock, $100,000. Hagerstown St. Ry. Co., Hagerstown, Md.; capital stock, $100,000; incorporators, P. M. Mishler, J. D. Main, C. L. Keedy and others. Natick Electric Street Ry. Co., Natick, Mass.; capital stock, $60,000; incorporators, J. R. Entwistle, of Framingham, H. H. Whitney, H. W. True and others, of Natick.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Plummers Springs, Mass.*—The bridge committee of Newburyport, Mass., has decided to build a stone bridge across the Artichoke River.

Freeport, Pa.—A bridge to cost $38,000, is to be built over the Allegheny River at this place.

Memphis, Tenn.—City Engineer, Niles Meriwether has prepared plans for an iron bridge over Bayou Gayoso. The structure is estimated to cost $13,000.

Spokane, Wash.—Bids will be received until Aug. 20, for building a bridge over the Spokane River, at Howard St. Oskar Huber, City Engineer.

HIGHWAYS.

Pennsylvania.—The Town Council of the borough of Newton, Bucks Co., has let a contract for macadam and telford roads to Kent & Bergen, of Chester Co. A 15-ton roller will be used. The borough will issue $16,400 in bonds.

Michigan.—A macadam road is to be built from Bay City to Essexville at a cost of $10,000. West Bay City will also build some macadam roads.

Arkansas.—The river road turnpike in Pulaski Co. is being built by convict labor, with satisfactory results. The convicts are leased to the contractors, Reinman & Cook.

California.—The Bear Valley Wagon Road Co. has been organized at San Bernardino. President, H. M. Barton; Secretary, J. H. Boyd; capital stock, $10,000. The road will be 38 miles long.

WATER-WORKS.

NEW ENGLAND.

Newport, Me.—There is talk of works, with a supply from a pond or by pumping from Lake Sebasticook.

Pittsfield, Me.—The Douglas Dam Water Power Co. has been organized with Robert Dobson President and J. W. Marson Secretary. A timber dam 365 ft. long, 10 ft. high, 20 ft. broad at the base, will be built. Water-works may be built, utilizing a part of the power developed.

Ashland, N. H.—Surveys for works have been made by John Kenistou, Plymouth, for the town. Proposed supply, Jackson Pond, 113 to 308 ft. above town and 2 1-5 miles from Main St. Five miles of pipe and 40 hydrants will be needed if the works are built.

Bristol, N. H.—N. H. Munsill, Malone, N. Y., proposes to build a reservoir this fall or next spring, 50 × 100 ft. × 15 ft. deep, 212 ft. above the village.

North Troy, Vt.—It is reported that J. W. Currier is building a reservoir, for works, 150 × 200 ft., × 8 ft. deep, nearly 200 ft. above the village. Supply, springs.

Barre, Mass.—Works are talked of.

Lowell, Mass.—It is reported that 6 experimental wells will be sunk.

New Bedford, Mass.—It is reported that a syndicate stands ready to buy the works. It is altogether improbable that they will have a chance.

MIDDLE.

Alfred, N. Y.—Works are projected. Address P. A. Burdick.

Brocton, N. Y.—There is talk of building works.

Rome, N. Y.—A 20-in. main 1,000 ft., and a 16 in. 700 ft. long are proposed.

Walden, N. Y.—Fire protection works are projected. E. A. Nichols is Village Clerk.

Walton, N. Y.—The Walton Water Supply Co. has been incorporated by E. R. Howland, A. E. Ogden and others; capital stock $15,000.

Hyndman, Pa.—It is reported that the Hyndman Water Co. has been incorporated by J. K. White, W. J. Carpenter and others.

McDonald, Pa.—It is reported that works will be built.

Moxerton, Pa.—It is reported that works will soon be in operation.

Reading, Pa.—Contracts have been let to the Tamaqua Manufacturing Co. for hydrants at $27 each, and the Meilert Foundry & Machine Co. for 16, 20 and 24-in. c. i. pipe at $26.75. Bids for a car load of pig lead are wanted.

Milford, Del.—The following is from Nathan Pratt, Chairman Water Board:

It is expected that contracts for works to be owned by the town will be let about Aug. 15. Supply, well, pumping to stand-pipe. Cost, $25,000. Population, 2,600.

SOUTHERN.

Wheeling, W. Va.—There is talk, merely, of obtaining water from a new source.

Elizabeth, N. C.—The engineer for the proposed works thinks that a supply can be obtained from wells at an average depth of 60 ft.

Barnesville, Ga.—The following is from J. J. Rogers:

Works have been talked of for some time, and I now propose to put them through with private ownership if the town will not build. Supply, springs and stream, pumping to reservoir or tank. Population, 2,500.

Hawkinsville, Ga.—Authority to issue $15,000 of bonds for works has been asked. The town has a well.

Gainesville, Fla.—The following is from H. E. Day, Mayor:

An election will be held Aug. 15 to see whether the town will issue bonds for works to cost $50,000. Supply, spring, pumping to stand-pipe. Population, 5,000.

Green Cove Springs, Fla.—Three propositions for building works have been made to the council.

Pell City, Ala.—C. D. Pratt, Town Treasurer, informs us that a ram will force water from a spring to a stand-pipe 140 ft. above the town.

Port Gibson, Miss.—The following is from M. S. Hasie, Vicksburg, who holds a franchise for work here:

It is proposed to organize the Port Gibson Water-Works Co., composed of local capitalists, and build works estimated to cost $20,000. Supply, Bayou Pierre, pumping direct. Population, 2,000.

Harrodsburg, Ky.—It is reported that J. A. Geary and J. F. Roche, Lexington, have received the franchise for works.

NORTH CENTRAL.

Ashtabula, O.—The Ashtabula Suburban Water & Light Co. of Chicago has been incorporated under the laws of West Virginia; capital stock, $50,000.

Cleveland, O.—It is reported that plans are being made to extend the intake tunnel further into the lake.

Toledo, O.—A contract for a new 15,000,000-gall. pumping engine has been awarded to the Henry R. Worthington Co., New York, for $80,000.

Connelton, Ind.—The following is from W. C. Henning:

Franchise for works was granted, but has been forfeited by failure to begin construction. Population, 2,800. This town and another, about three miles below, with population of 2,500, could be supplied by one system, and correspondence is desired with parties who wish to secure franchises.

West Indianapolis, Ind.—The Indianapolis Water Co., it is reported, will extend its works to supply this town, laying about 9,000 ft. of 12 and 6-in. pipe.

Bay City, Mich.—Bids will be received until Aug. 25 for about 1,500 tons of 6, 16 and 20-in. cast iron pipe.

Jackson, Mich.—W. R. Coats has reported in favor of a 30 × 30 ft. reservoir or pump well and an elevated steel tank 75 ft. in diameter by 32 ft. high on a masonry tower 60 ft. high; also about ¾ miles of 16-in. pipe to connect the present tubular well with the new pump well. Estimated cost, $73,350.

Nashville, Mich.—Aug. 21 a vote will be taken on building $24,000 direct-pumping works.

Effingham, Ill.—The Council has appointed a committee of five of its members to receive bids for a franchise.

Peru, Ill.—The Peru Water-Works Co. has been incorporated; capital stock, $70,000. The franchise has been accepted from the city, and the contract for building works let to E. Sutphin, Kansas City, for $60,000.

Tuscola, Ill.—An election to vote on bonding the town for $10,000 for works will be held Aug. 29.

Marshfield, Wis.—The Council has granted a franchise for works to Moffett, Hodgkins & Clarke, Syracuse, N. Y. There will be 7½ miles of mains and 68 hydrants, the latter at an annual rental of $4,000. The works are to be completed by Mar. 1, 1892.

NORTHWESTERN.

Mount Pleasant, Ia.—It is reported that on Aug. the citizens will vote on buying the company's works for $32,500. If the vote is adverse it is said that a new company will be organized to take the works.

Washington, Ia.—Bids for building works will be received by the Council until Aug. 17.

Duluth, Minn.—At a special election the people voted, 568 to 122, for the issuance of $800,000 of water bonds. The vote also stood 287 in favor of building new works, to be owned by the city, and 80 in favor of buying the company's work. The vote was on three distinct propositions. From the information at hand it seems that the plan is to supply, at present, those parts of the city not supplied by the company, and eventually to supply the whole city. It is proposed to erect a pumping station on the north shore of Lake Superior, near the mouth of Lester River, and force water to to a high service reservoir. City Engineer E. H. Keating has made a preliminary estimate of the cost of establishing pumping works, low and middle service reservoirs, and middle and high service pumping stations and the necessary force mains. The estimated cost is $1,000,000, not including the distributing system.

Beatrice, Neb.—The following is from O. V. P. Stout, City Engineer:

Bids will be received by the Council until Sept. 8 for material and labor in connection with water-works improvements, including 2,000,000-gall. well supply, 6,400 ft. 12-in. cast-iron pipe, specials, 12,000 lbs. lead, a 1,500,000-gall. compound condensing engine and 7½ × 16-ft. boiler; also moving and resetting engine and boiler.

PACIFIC.

Tacoma, Wash.—The North End Water Co. has been incorporated by R. B. Mullen, Anna Mullen and F. M. Harsberger to develop the "Mullen Water-works" in a section where the Light & Water Co.'s mains do not extend; capital stock, $40,000.

CANADA.

Sandwich, Ont.—Bids will be received until Aug. 1 for furnishing and laying mains; material and labor estimated to cost $15,000. Bids will also be received for $15,000 of 30-year 5% bonds. Address J. A. Stuart, Town Clerk.

ARTESIAN WELLS.

Collinsville, Ill.—The Council has appropriated $5,000 for sinking a well for water works.

Mexico.—It is reported that the State of Sonora has contracted with Mr. W. Loaiza to sink several wells in different localities.

IRRIGATION.

New Companies.—Cañon Ditch Co., Missoula, Mont.; $50,000; Hiram Knowles, F. G. Higgins and others. McGee Irrigating Ditch Co., Sterling, Tex.; $5,000. Alisos Water Co., Santa Barbara, Cal.; $9,000. C. C. Sherman, William Ealand, and others.

SEWERAGE AND MUNICIPAL.

Sewers.—*Massachusetts.*—Brockton. The Lewis-Mercer Construction Co., of New York, has made a proposition to put in a system of sewerage.—Medford. The town is said to need a system of sewerage, a number of cesspools now discharging into a brook.—Leominster. An appropriation of $2,500 for sewers has been voted.—Easthampton. A sewer is being laid out by Mr. W. W. Strong, of North Hampton.

Rhode Island.—Woonsocket. The Sewer Committee will visit the sewage disposal works at Cranston, R. I., and at Worcester, South Framingham and Lawrence, Mass.

New Jersey.—Orange. The tidal basin at Woodside will be an enlargement of the sewer at that point, to accommodate for less than 12 hours the flow from this city, and possibly three other townships. The chamber will be air-tight and completely under ground. No sewage will lie in it long enough to become putrid, and it will be occasionally cleaned out thoroughly. The sewage that will pass through this tidal chamber will be only the refuse from houses.

Ohio.—Middletown. A sewer system is to be built by the Middletown Sewer Co.—Toledo. A syndicate proposes to raise $250,000 for sewage.

Washington.—North Yakima. The contract for the sewerage system has been awarded to F. Schmidt at $36,000. The bonds were sold in the spring for $54,000.

California.—Oakland. Land has been purchased for a pumping station for the main creek sewer.—Mayfield. A sewerage system is projected.

Streets.—*Massachusetts.*—Holyoke. The city has ordered 52,000 compressed asphalt paving blocks, weighing 20 lbs. each.—New Bedford. The sum of $25,000 has been voted for the street department.

Pennsylvania.—Souderton. The borough streets are being macadamized.—Scranton. There is some dissatisfaction with the new law, under which the cost of sewers is assessed according to benefits instead of according to frontage.

Georgia.—Macon. The city has ordered sidewalks to be laid by property owners, and they will be prosecuted if the work is not done.

Ohio.—Martin's Ferry. Broadway is to be paved with brick from fence to fence, dispensing with curbing and separate sidewalks, and only retaining a gutter between the road and sidewalk.

Bonds.—Taunton, Mass., $25,000 for paving, $10,000 for

water-works. Olympia, Wash., $200,000 for public improvements. Portland, Ore., $500,000 for bridge; E. A. King, Clerk of Bridge Committee, Aug. 17. Eaton, O., $67,000 for water-works; Isaac Sliver, Village Clerk, Aug. 20.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable at Huntsville, Tex., address W. S. Gibbs; Ellicott City, Md., address J. Schrieber, of Baltimore; Graham, Va., address the Graham-Bluefield Electric Co.; Harriman, Tenn., address the Cumberland Mfg. Co.; Pass Christian, Miss., address C. M. Rhodes; Ellenville, N. Y.; Franklin, Va., address W. W. Moore; Morris, Ill.; Marion, Ind.; Centreville Ia.; Luling, Tex.; Berwyn, Ill.; Harleysville, Pa.

Leesburg, Va.—Mayor H. O. Clagett will receive bids until Aug. 29, for street lighting by either gasoline or electricity.

Aiken, S. C.—The electric light works are being pushed at Etheridge's mill and the Langley, Graniteville and Vanduse mills will soon be lit by electricity. These mills will take 1,000 lights in addition to those for the villages. As soon as the work in these places is completed, the wires will be brought to Aiken and lights introduced here.

Augusta, Ga.—The Mayor has advertised for bids for street lighting with 250-arc lamps of 2,000 c. p., 125 incandescent lights of 32 c. p., and 75 incandescent lights of 65 c. p. The City Council has instructed its Lamp Committee to inquire into the advisability of erecting a municipal plant. Sealed bids will be received for constructing a plant with a capacity of not less than 300 arc lights, 150 incandescent lights of 32 c. p., and 100 of 65 c. p., the bids to include cost of material, dynamos, labor, etc., and the plant to be in operation by July 1, 1892

Marion, Ind.—The City Council has voted to purchase an arc light plant of 100 lamps capacity, and to operate the same in connection with the water-works. The plant will cost in the neighborhood of $22,000, and probably run with Wood machinery.

Bushnell, Ill.—The boiler in the electric light station exploded Aug. 10, killing two men and wrecking the station, which had a capacity of 30 arc and 600 incandescent lamps.

Villisca, Ia.—The city has voted to install a municipal plant.

Worthington, Ia.—The city has voted to issue bonds for water-works, and an electric light station.

New Companies.—Columbia Motor & Construction Co., Chicago, Ill.; capital stock, $50,000; incorporators, J. Erd, L. E. Sherman, G. W. Myers, G. Sutherland. Riverside Edison Co., Riverside, Ill.; capital stock, $40,000. Maryville Electric Light & Power Co., Maryville, Mo.; capital stock, $25,000. Washington County Electric Light & Power Co., Cambridge, Shushan and Salem, N. Y.; capital stock, $10,000; incorporators, D. Zeiserand, of Troy; F. C. Lovejoy, of Shushan; J. D. Hall, of Cambridge.

PROPOSALS OPEN.

Water-Works.—***Beatrice, Neb.***—Construction of work of 2,000,000 galls. daily capacity, in connection with present mains; 6,400 lin. ft. of 12 in. cast iron pipe; tees, bends, etc.; compound condensing engine of 1,500,000 galls. daily capacity; later and condenser, etc. Bidders to make their experiment and guarantee supply. E. D. Wheelock, Water Commissioner. Sept. 8.

Dredging.—About 550,000 cu. yds. at Port Reading, on Arthur Kill. A. J. McBean, contractor, Port Reading R. R., Metuchen, N. J. Aug. 20.

Sewers.—***Bangor, Me.***—Sewer pipe, Aug. 18. Sewer construction, Aug. 20. The City Clerk.

Iron Work.—***Indianapolis, Ind.***—For store house; about 100,000 lbs. of girders formed of I-beams in pairs; channels, wrought and cast-iron plates, cast-iron pilasters, etc.; also iron fence. Major Clifton Conly, U. S. A., Indianapolis Arsenal. Aug. 41.

Street Work.—***Washington, D. C.***—About 2,800 sq. yds. Portland cement granolithic pavement, and 464 lin. ft. of circular granolithic curbing. Col. O. H. Ernst, U. S. A., Office of Public Buildings and Grounds. Aug. 22.

Columbus, O.—Asphalt, stone block, Hayden block, Hallwood block, fire clay or hard-burned brick pavement. F. M. Senter, Clerk of Board of Public Works. Aug. 18.

Canal.—Improving 3,200 lin. ft. of the Champlain Canal. Edward Hannan, Superintendent of Public Works, Albany, N. Y. Aug. 24.

Sewers.—***Providence, R. I.***—R. E. Smith, Commissioner of Public Works, Aug. 20.

CONTRACTING.

Street Work.—***Dunkirk, N. Y.***—The contracts for brick paving on Central Ave. and Lion St. have been awarded to Harrold, Dutro & Rickard, of Beaver Falls, Pa. Excavation, 35 cts. per cu. yd.; pavement, $2.40, $2.44 and $2.49 per sq. yd. with asphaltic cement filling; $2.28, $2.32 and $2.37 with Portland cement filling; curbing, 50 cts. per lin. ft.; curb corners, 65 cts. per lin. ft.; curbing reset, 15 cts. per lin. ft.; crosswalks, 60 cts. per sq. yd.; crosswalks relaid, 12 cts. per sq. yd.; drain tile, 13 cts. per lin. ft. The brick will be supplied by the Park Fire Clay Brick Co., of Beaver Co., Pa., and the Portland cement grouting will be used.

Columbus, O.—The contract for Hallwood block pavement has been awarded to the Ohio Paving Co. at $2.65 per sq. yd.

Paving Blocks.—***Fitchburg, Mass.***—The contract for granite blocks has been awarded to F.A. McCanliff, of Fitchburg, at $1.45 per sq. yd., delivered on the street. Mr. J. A. Battles is Superintendent of Streets.

Dredging.—The following proposals for dredging and improving Cedar Bayou have been received by Major C. J. Allen, U. S. Engineer Office, Galveston, Tex.: A. M. Shannon, Galveston; 25,000 cu. yds. of dredging, 24 cts. per cu. yd.; 350 cords of brush mattress in place, $6 per cord; 3,200 cu. yds. of stone in place, $2.50 per cu. yd.; total, $17,300. Charles Clark, Galveston; 28 cts., $7, $2.50, $18,850.

Wing Dams.—Proposals for wing dams in the Savannah River near Augusta, Ga., have been received by Capt. O. M. Carter, U. S. Engineer Office, Savannah, Ga. The bidders are as follows: *A*, J. T. Gaynor, Fayetteville, N. Y.; *B*, J. Friday, Charleston, S. C.; *C*, S. W. Skinner and T. E. Wallace.

	A	*B*	*C*
	$	$	$
Mattresses, 7,500 cu. yds. (fascines)	1.29	1.61	2.10
Stone, 4,000 cu. yds	2.69	3.15	3.10

Sewers.—***Boston, Mass.***—Proposals were received Aug. 5, by the Metropolitan Sewerage Commission, for the construction of three sections of main sewers. The bidders were as follows: *A*, Troy Public Works Co., Troy, N. Y.; *B*, Dennis O'Connell, Dorchester, Mass.; *C*, National Construction Co., Boston; *D*, R. A. Malone & Son., Philadelphia, Pa.; *E*, Metropolitan Construction Co., Boston; *F*, C. McBride, Boston- *G*, R. Falvoye and M. Buttimer, Somerville, Mass.; *H*, D. C. Collins and E. Fitzgerald, Somerville; *I*, A. A. Libby & Co., Boston. The work is as follows: Section 15, Chelsea; Sections 16 and 17, Everett.

Sec. 15.	Earth Exca. and Refill. 1,730 lin. ft.		Rock Exca. 50 cu. yds.	Brick Masonry. Amer.can. 1,000 cu. yds.	Brick Masonry. Portland. 600 cu. yds.	Concrete Masonry. American. 1,000 cu. yds.	Concrete Masonry. Portland. 225 cu. yds.	Rubble-stone Masonry. American. 500 cu. yds.	Spruce Lumber in place. 130 M. ft. B.M.	SprucePiles driven. 2,000 lin. ft.	Earth Exca. and Refill in outside of Trench. 500 cu. yds.	Total.
	$		$	$	$	$	$	$	$	cts.	$	$
A	12.00	.....	5.00	12.50	14.00	5.00	6.50	6.00	30	50	1.25	56,807
B	10.30	.....	3.00	13.40	14.50	5.50	6.75	6.00	29	20	1.00	54,757
C	10 35	.....	5.00	12.87	14.37	5.75	7.25	5.50	30	17	1.25	54,643
D	11.80	.....	5.00	11.75	14.00	5.75	6.25	6.00	20	16	.50	54,140
E	10.92	.....	1.00	11.85	14.85	5.75	7.85	3.00	27	14	1.25	53,155
F	9.45	.....	.90	13.45	14.50	5.00	6.50	6.25	30	20	.75	52,806
Sec. 16.	Sewer. 98 × 106 ins. 3,590 ft.	Sewer. 70 × 76 ins. 840 ft.	50 cu. yds.	3,000 cu. yds.	1,500 cu. yds.	600 cu. yds.	500 cu. yds.	500 cu. yds.	30 M. ft. B. M.	1,000 lin. ft.	500 cu. yds.	
	$	$	$	$	$	$	$	$	$	cts.	$	$
A	20.00	10.00	5.00	13.00	14.50	5.50	7.00	6.50	30	50	1.25	153,275
C	14.25	8.27	5.00	15.05	16.55	6.50	8.00	7.50	30	17	1.75	141,924
E	14.70	7.75	2.00	13.38	15.85	7.45	9.80	3.00	27	14	1.25	135,743
D	13.50	8.50	5.00	12.00	14.25	5.50	6.25	6.50	20	20	.50	123,955
Sec. 17.	Sewer. 70 × 76 ins. 3,350 ft.	Sewer. 54 × 61 ins. 1,828 ft.	50 cu. yds.	1,600 cu. yds.	1,000 cu. yds.	400 cu. yds.	150 cu. yds.	325 cu. yds.	16 M. ft. B. M.	500 lin. ft.	500 cu. yds.	
	$	$	$	$	$	$	$	$	$	cts.	$	$
C	10 37	8.75	5.00	14.15	15.65	6.25	7.75	7.25	30	17	1.75	96,733
D	10.80	9.70	5.00	12.50	14.50	5.50	6 50	7.00	20	20	.50	94.781
A	10.00	9.00	5.00	12.75	14.25	5.25	6.75	6.25	30	50	1.25	91,350
G	9.50	6.75	3.00	12.50	14.50	5.00	7.00	6.50	30	24	.75	84,951
E	9.33	5.25	1.00	12.09	14.49	6.47	8.87	3 00	27	14	1.25	80,757
H	7.50	6.75	4.00	12.90	14.50	5.75	7.00	6.00	29	20	1.00	79,168
I	6.33	5.33	.01	13.95	15.00	6.00	7.25	6.00	25	16	1.00	74,696
F	7.00	4.50	1.00	13.60	15.00	5.00	6.50	6.00	32	50	.75	74,548

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Locomotive Works, o Schenectady, N. Y., have built 3 double-end engines for suburban service on the New York Central. The Rhode Island Locomotive Works, of Providence, R. I., have an order for 10 locomotives for the Canadian Pacific. The Pennsylvania road is building a heavy express pas enger engine at its Altoona works. The Canadian Pacific has ordered 50 engines. The Western New York & Pennsylvania has added to its equipment 6 consolidation and 3 six-wheel switch engines; a Baldwin compound has also been ordered. The Cincinnati, New Orleans & Texas Pacific is selling a number of its light engines. The Raub Locomotive Co., of New York, has been incorporated by D. C. Raub and J. H. Barrett, Paterson, N. J.; W. C. Raub, St. Louis, Mo.; A. Sibley, Brooklyn, N. Y.; Jesse Larrabee, New York, N. Y.; $5,000,000.

Cars.—The Harvey Steel Car Co., of Chicago, Ill., has built 10 box cars for the Calumet & Blue Island. The St. Charles Car Co., of St. Charles, Mo., has contracts for 6 chair cars and 250 box cars for the Wabash. 250 box cars for the Mexican National, and sleeping cars for the Krebiel Palace Car Co. The Buffalo Car Co., of Buffalo, N. Y., has an order for 200 box cars for the Fall Brook Coal Co. The Canadian Pacific has given orders for 1,500 box cars.

Car Heating.—The Gibbs' steam coupler, manufactured by the Safety Car Heating & Lighting Co., of New York, N. Y., has been adopted by the Philadelphia & Reading, Central of New Jersey; Pennsylvania, Poughkeepsie & Boston; Central New England & Western; Boston & Maine, and Pullman Car Co., for the Washington and Boston through service. This coupler has also been adopted by the Chicago, Rock Island & Pacific, and is being fitted to all the steam heating equipment of that road, the use of the Sewall coupler being discontinued, so it is stated.

Car Heating.—The Morton Safety Heating Co., of Baltimore, Md., has a contract to fit its heaters to the cars of the Belt Line, Toronto, Canada.

Railway Shops.—The buildings of the Northern Pacific shops at Tacoma, Wash., have been completed by A. McMullen & Co., the contractors. Most of the machinery is in place, shafting is being hung, and the contract is nearly completed. The shops will probably be ready within 2 months.

The Gillette-Herzog Mfg. Co. is the new title of the Herzog Mfg. Co., of Minneapolis, Minn., engaged in the manufacture of architectural iron work, riveted and foundry work.

Companies.—Interstate Terminal Construction Co., of Jersey City, N. J.; to build railways, tunnels, etc.; Charles McVeagh, Morristown, N. J.; J. Kelly, Brooklyn, N. Y.; Lester Ryan, New York, N. Y.; $20,000. Summit Railroad Equipment Co., of Trenton, N. J.; A. N. Martin and C. E. Kimball, Summit, N. J.; H. A. V. Post and C. C. Pomeroy, New York, N. Y.; $1,500,000. Chapel Automatic Railway Gate Co., of Marengo, Ill.: E. A. Chapel and C. H. Donnelly; $100,000. Richards' Momentum Brake Co., of Jersey City, N. J.; H. S. Richards, Orville, Pa.; Lindley Murray, Brooklyn, N. Y.; A. A. Rice, Jersey City, N. J.; $100,000. Pressed Steel Brake Beam Co., of Pittsburg, Pa. Chicago Flint Paring Co., of Chicago, Ill., F. E. Bennett, A. Lepreux, J. A. Lamon; $20,000.

Metal Market Prices.—***Rails.***—New York: $30.75 to $31; old rails, $21.50 for iron and $17 for steel. Pittsburg: $30; old rails, $23 to $23.50 for iron and $17.50 to $18 for steel. Chicago: $31.50 to $32.50; old rails, $23.25 for iron and $14 to $16 for steel.

Track Materials.—New York; steel angle bars, 1.75 to to 1.8 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.7 to 2.8 cts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.75 cts. with square and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $18. Pittsburg: $14.75 to $16.75. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 52½ and 42½ per cent. on black and galvanized butt-welded; 62½ and 50 per cent. on black and galvanized lap-welded. Casing 55 per cent.

Lead.—New York: 4.4 to 4.5 cts. Chicago: 4.4 cts. St. Louis: 4.2 to 4.22½ cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams 2. 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2.05 cts.; sheared steel bridge plates, 2.1 to 2.15 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.1 cts. for tank, 2.35 cts. for shell, 2.55 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.1 to 2.2 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.15 to 2.2 cts.; sheared plates, 2.25 to 2.35 cts. for iron; steel plates, 2.4 to 2.6 cts. for tank, 2.85 to 3 cts. for shell, 3 to 3.25 cts. for flange; 4.5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.